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FORT BENNING LAND-USE PLANNING AND MANAGEMENT STUDY

by

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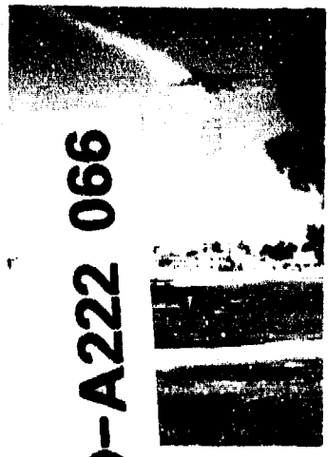

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This report presents and describes a land-use planning methodology designed for implementation on US Army installations. The methodology assimilates and displays natural resource, military training, and sociological data in a geographic information system (GIS) format that is combined with a computerized management information system (MIS) designed to plan current and future land uses in a manner that minimizes potential resource use conflicts. The Earth Resources Data Analysis System GIS and the LANDMENU MIS were used to develop a prototype natural resource management plan for Fort Benning, GA and to provide both general and specific land-use recommendations based on original soils, timber, wildlife, military training, and sociological data gathered on the installation.

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PREFACE

This report presents procedures, results, and recommendations from the Fort Benning Land-Use Planning and Management Study. It discusses methods for data collection, especially for timber and wildlife management, and how these data should be input and analyzed using a geographic information system (GIS). The report also discusses the resolution of conflicts between military training needs and requirements for natural resource management. Methods presented here represent an initial effort to greatly expand the capability of installations to resolve the many complex problems associated with integrated management of natural resources in a training environment.

The study was sponsored by the US Army Training and Doctrine Command (TRADOC). TRADOC project monitors were Messrs. Tom Newkirk and Jim Sabo. Mr. Chris Dunn was the TRADOC point of contact at Fort Benning. The study was conducted by personnel of the Environmental Resources Division (ERD), of the Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). The work was conducted under the general supervision of Dr. Conrad J. Kirby, Chief, ERD, and Dr. John Harrison, Chief, EL. Principal investigators for the study were Messrs. Michael R. Waring, Resource Analysis Group (RAG), and Hollis H. Allen and James W. Teaford, Wetlands and Terrestrial Habitat Group, EL.

GIS data input and analysis were provided by Messrs. Wayne McCormick, IPA, Southern Illinois University and Derrick Wells, contract student, Jackson State University. Additional data collection and analysis of management objectives were provided by Mr. Derwood Jones, US Army Engineer Division, Southwestern.

Soils data were collected and correlated by US Department of Agriculture Soil Conservation Service personnel. These included: Messrs. Alfred Green and Robert Stevens, Survey Leaders for Georgia and Alabama, respectively; Messrs. Talbot R. Gerald and Robert L. Wilkes, State Soil Scientist and Assistant State Soil Scientist, respectively, for Georgia; and Messrs. John C. Meetze and Glenn L. Hickman, State Soil Scientist and Assistant State Soil Scientist, respectively, for Alabama. Dr. Stephen G. Shetron, Forest Soil Scientist, Michigan Technological University, provided advice and guidance to WES during the formulation and conduct of the soil survey.

Timber and wildlife data collection and input were provided by: Messrs. Salomon Ali, Tyler Baker, Chris Bishop, John Coker, Bruce Dueitt, Scott Friedhof, Kenneth B. Masten, William Roberts, Jeffery Ware, and Elton Wright, and by Mses. Metta Byrd, Mary Beth Grogan, Lisa Glueck, Tamara Graham, Viveca Jefferson, Patricia Tyler, Cathy Young, and Melanie Young.

Technical review of the report was provided by Mr. H. Roger Hamilton, RAG, and Mr. John L. Tingle, Battlefield Environment Group, EL. Editorial review was provided by Ms. Janean Shirley of the WES Information Technology Laboratory.

COL Larry B. Fulton, EN, was Commander and Director of WES. The Technical Director was Dr. Robert W. Whalin.

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CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
acres	4,046.873	square metres
feet	0.3048	metres
inches	2.54	centimetres
pounds (mass) per acre	0.000112	kilograms per square metre
pounds (mass) per square foot	4.882428	kilograms per square metre
square feet	0.09290304	square metres
square mile	2.589998	square kilometres

PART I: INTRODUCTION

Background

1. In September 1983, the US Army Engineer Waterways Experiment Station (WES) initiated a study at Fort Benning, Georgia at the request of the Department of the Army Training and Doctrine Command (TRADOC) to investigate integrated land-use planning and management. The overall goal of the study was to produce a prototype methodology for the allocation of lands among many competing uses, with special emphasis on natural resources. A study plan consisting of nine separate tasks was used to achieve this goal. These tasks included:

a. Task I. Conduct preliminary field investigation.

b. Task II. Review statutes and regulations on land use.

c. Task III. Review mission land requirements.

d. Task IV. Inventory natural resources.

e. Task V. Review potential demand for alternative land uses.

f. Task VI. Determine potential land uses.

g. Task VII. Determine existing management objectives.

h. Task VIII. Determine land suitability.

i. Task IX. Develop preliminary allocation method.

Many of these tasks, although listed separately, were conducted concurrently. The preliminary field investigation was used to further define the research approach and determine the extent, nature, and quality of existing data bases. Although data existed in some areas, many of the data were either too general to be of use or needed extensive field work for verification or expansion. Data were available for hydrology, historical/archaeological features, endangered species (needed verification), soils (an Order-2 soil survey was available for Muscogee County only), some forestry and wildlife parameters, and cross-county mobility. This task resulted in a revised work plan that was presented to, and accepted by, TRADOC in January, 1984.

2. For Task II, all relevant statutes and regulations were reviewed for land-use planning, natural resource management, cultural resource protection,

endangered species, and related areas of concern. This review included publications at the Federal, state, and local levels. Results of this task were delivered to TRADOC in an internal report in February, 1985.

3. Tasks III through IX form the basis for this report and for the methodology. Task III, review of mission land requirements, was one of the most important since training is the primary objective for any military installation (also referred to as post). Data on environmental settings and requirements necessary for the proper conduct of infantry and mechanized infantry training were obtained through a series of interviews with the primary trainers in each unit and with personnel in the Department of Plans and Training (DPT). Historical training records were summarized to determine how and where training was taking place. Initially, it was hoped that trainers could identify specific types of terrain and natural resources needed for different training scenarios. However, this did not materialize; in most cases, it appears that the trainers are assigned an area to use regardless of the suitability of the resource for supporting a particular type of training.

4. Based on information collected in the preliminary investigation, additional inventories were needed for forestry, soils, and wildlife (Task IV). A cooperative research agreement with the US Forest Service was used to complete forest data collection that was started by the Fort Benning staff as part of the ongoing management. Additionally, this agreement provided for the collection of wildlife habitat data. This task consumed the greatest amount of time and funding in the study. Results and recommendations from this task are discussed in detail in various sections of this report.

5. Soils information was also found to be inadequate, with only one-third of the post (Muscogee County, Georgia) completed. Through an agreement with the US Department of Agriculture (USDA) Soil Conservation Service (SCS), Order-2 soil surveys were completed for the remainder of the post in Georgia (Chattahoochee County, 80,000 acres*) and Alabama (part of Russell County, 12,000 acres). Soil types were delineated on a scale of 1:25,000 to coincide with available military maps. Additional soils information from the Fort Benning Terrain Analysis (US Army Engineer Topographic Laboratory 1976) was also included in the data input.

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 4.

6. Under Tasks V and VI, the potential demand for alternative, non-mission-related uses of installation lands was examined and then compared to the resource data and military mission for compatibility. Special emphasis was given to potential revenue-generating land uses such as agricultural leasing, recreation, and forest products. In general, it was found that current practices seem to be the best for the situation. Little demand exists fro row crop production and agricultural leases (hay, grazing) are generally not compatible with the military mission. Revenues could, however, be generated through a restructuring of current policies regarding hunting and fishing.

7. General goals, objectives, and management requirements at all levels in the chain of command were examined in Task VII. Restrictions from use based on safety and security considerations were noted. Also, specific goals and objectives for morale support, economic (timber production, etc.), aesthetic, and environmental (endangered species, erosion control, etc.) concerns were examined. In many cases, clearly delineated goals and objectives had not been written, while in other cases they had not been followed because they were only understood in very broad terms.

8. Based on management objectives, mission land requirements, potential land uses, and resource inventories, a series of land suitability maps were constructed in Task VIII. Natural resource suitability maps provided an indication of what a particular compartment may be suitable for, based on the complex interaction of such factors as site index, hydrology, existing forest type, and the location and abundance of sensitive areas (endangered species colonies, archaeological/historical sites, fragile timber). Military suitability maps are based on erosion potential, slope, sensitive areas, transporation needs, and cross-country mobility requirements. These maps helped form the basis for developing the prototype allocation process in Task IX.

9. The final task was to develop a prototype allocation process. This will be discussed in detail in additional sections of this report.

Study Area

10. Fort Benning, Georgia, was selected as the study site for developing the methodology, based on three main criteria: (a) Fort Benning has varied and abundant natural resources, (b) it is a center for both infantry

and mechanized training, and (c) it has an in-place and functioning geographic information system (GIS). The post consists of approximately 182,000 acres, with 16,000 acres in cantonment areas, 33,000 acres in ranges and impact areas, and the remaining 133,000 acres in maneuver training areas. The maneuver areas are the primary focus of this study.

11. The entire post is divided into training compartments that range in size from less than 1,000 acres to over 2,000 acres. They are generally bounded by roads or recognizable streams. Both training and natural resource management are practiced on a compartmental basis.

Methods

12. Specific responsibilities for the various tasks in the study were divided between the Resource Analysis Group (RAG) and the Wetlands and Terrestrial Habitat Group (WTHG) of WES. RAG was primarily responsible for all tasks except the natural resources inventory. RAG was further responsible for the input of all data, including natural resources, into the RAG GIS. This GIS was fully compatible with the Fort Benning GIS.

13. WTHG was assigned three major responsibilities. These were: (a) to provide a comprehensive inventory of forestry and wildlife habitat resources of the installation; (b) to provide a comprehensive inventory of the soil resources of Chattahoochee County, Georgia, and of Russell County, Alabama; and (c) to provide natural resource management recommendations to Fort Benning personnel that could be incorporated into an integrated management plan to be prepared by that installation.

14. Although each group had specific responsibilities, extensive coordination and interaction were necessary. Both the allocation methodology and the resource management plan reflect this joint effort.

Data input

15. All data for the study were input into either a data base management system (dBASE III Plus, copyright Ashton-Tate, 1985) or, where appropriate, digitized into an Earth Resources Data Analysis System (ERDAS) IBM PC/AT-based GIS. Military variables included, but were not limited to, slope, erosion potential, camouflage potential, firing ranges and points, transporation factors, streambank slope and gap factors, and landing zones.

Resource variables included soil type, forest type, age, condition class, hydrology, endangered species habitat, archaeological/historical sites, and wildlife habitat. All data were input at a 10-m resolution (pixel size) in the GIS. In some cases, these were also aggregated to 100-m resolution. Primary input scales were 1:12,000, 1:24,000, 1:25,000, and 1:50,000.

Inventory of forestry and wildlife habitat resources

16. Fort Benning personnel had begun an inventory of their timber resources prior to the initiation of the land-use study. Their inventory was patterned after the US Forest Service (USFS) procedure known as the Continuous Inventory of Stand Conditions (CISC) as described in USFS Handbook 2409.21d-R8 Silvicultural Examination and Prescription Handbook, with amendments (USFS 1977). These procedures were modified by WES to add selected data required to implement habitat suitability index (HSI) models developed by the US Fish and Wildlife Service (FWS) as a part of the FWS habitat evaluation procedures (HEP).

17. HSI models for the following five species were modified for use at Fort Benning: (a) white-tailed deer (*Odocoileus virginianus*); (b) eastern wild turkey (*Meleagris gallopavo*); (c) eastern gray squirrel (*Sciurus carolinensis*); (d) northern bobwhite quail (*Colinus virginianus*); and, (e) red-cockaded woodpecker (*Picoides borealis*). These HSI models were evaluated and refined for Fort Benning by comparing model outputs on multiple study sites on the installation with scores assigned to the same areas by biologists considered to be experts in the habitat requirements of the various species. Mr. Ted Doerr, Dr. Thomas H. Roberts, and Ms. L. Jean O'Neil of WES coordinated the HSI model modification procedure, while the following biologists served as species authorities: Dr. M. R. Lennartz, USFS (red-cockaded woodpecker); Dr. R. L. Marchington, University of Georgia (white-tailed deer); Dr. M. R. Pelton, University of Tennessee (eastern gray squirrel and white-tailed deer); and Dr. D. W. Speake, Auburn University (northern bobwhite quail and eastern wild turkey).

18. Once the appropriate variables and sampling procedures were selected, approximately 140,000 acres at Fort Benning were sampled for timber and wildlife habitat data (see Appendix A for details of sampling methods). As a result of field sampling, the pre-existing military training compartments were divided into forest stands for natural resource management purposes.

Individual stands were identified and characterized using forestry and wildlife habitat variables such as forest type, stand age, timber condition class, and HSI's. Specific management prescription recommendations were also developed by WES for each compartment.

Soils inventory

19. Soils data were available for Fort Benning lands occurring within Muscogee County, Georgia. However, no data were available for the installation lands in Chattahoochee County, Georgia, or Russell County, Alabama. Therefore, these lands were mapped in a similar manner and at the same level of detail (scale 1:12,000) as the Muscogee County soils to provide consistent soils data throughout the study area. Memoranda of understanding were developed between WES and the SCS in Georgia and Alabama to conduct Order-2 soil surveys on 80,000 acres in Georgia and 12,000 acres in Alabama. SCS personnel provided pre-publication maps (field-checked, correlated, and verified), soil mapping unit legends, descriptions of soil mapping units and soil series, and interpretative tables for installation lands in each county.

Management plan recommendations

20. Forestry and wildlife habitat management recommendations developed for Fort Benning are of two general types: (a) stand prescription and compartment summaries, and (b) management organization recommendations. The process of providing timber/wildlife habitat prescription recommendations has been introduced above and is addressed in more detail below.

21. The concept of management organization recommendations includes such items as: (a) organizational structure (i.e., personnel, responsibilities, lines of authority, etc.) for effective management of installation natural resources; (b) effective organization of the resource for management (i.e., regulation of the forest); and (c) natural resource principles and concepts for use as guidance in actually managing the resources. These various overview recommendations are presented in appropriate sections below, but the guiding philosophy behind them is in accordance with Jahn et al. (1984) in their report to the Secretary of the Army concerning natural resource management on Army lands.

PART II: LAND-USE PLANNING METHODOLOGY

Overview

22. The land-use methodology developed in this study actually consists of two distinct parts: (a) a prototype allocation process, based on a GIS, for all competing activities, and (b) a dBASE III Plus computer program, called LANDMENU, for analyzing and managing the forest and wildlife components of the installation. Actual step-by-step procedures for both the allocation process and the computer program are contained in a series of "workbooks" found in Appendices B and C, respectively. However, a broad overview of each of these parts in given in this section of the report.

Integrated Land-Use Allocation

Concept

23. The original concept for the land-allocation tasks in this study was to not only devise a prototype land-allocation process, but also to make a complete allocation of all lands among the many competing uses at Fort Benning. This concept was eventually modified, by mutual consent of both WES and TRADOC personnel, to include only the prototype portion of the concept. This decision was based on three major considerations:

a. Most importantly, no implementation and enforcement mechanism currently exists at Fort Benning to insure that allocation decisions are adhered to. This problem will be discussed in greater detail in Part IV of this report.

b. Somewhat similar studies on training area management, especially through the use of rotation, were/are currently being conducted by the Construction Engineering Research Laboratory.

c. The decision by the Department of the Army (DA) to implement the Geographic Resource Analysis and Simulation System GIS raised serious questions as to the utility of an ERDAS-based allocation. However, a prototype process, demonstrating only the broad concepts, could, in fact, be used on other systems.

24. In developing the process, the installation was subdivided into five sections to facilitate analysis and development of the prototype by allowing an entire area to be used at once while retaining the 10-m resolution. The five sections, with their respective training compartments (212, as defined by Fort Benning) were:

NW (Northwest) - M11 and M12
N (all)
O (all)

NE (Northeast) - K (all)

WC (West Central) - J (all)
L (all)
M1 - M10
P (all)
R (all)
S (all)
T (all)
DD3 (north of Hwy 280/27)

SE (Southeast) - C (all)
D (all)
E (all)
F (all)
G (all)
H (all)
I (all)

SW (Southwest) - A (all)
B (all)
Q (all)
V (all)
W (all)
X (all)
Y (all)
Z (all)
AA (all)
BB (all)
CC (all)
DD1 & 2 (south of Hwy 280/27)
EE (all)
FF (all)
GG (all)
KK (all)

25. It should be noted that a number of training compartment boundaries and designations changed during the course of the study. These changes were accommodated as much as possible.

GIS file organization

26. Files in the GIS include both the digitized data for all inventory data and the actual GIS files of both inventory and derived data. Basic inventory files include timber, wildlife, and soils from the WES inventory, plus numerous existing files on endangered species, archaeological/historical sites, (installation compatible-use zone) contours, etc. These existing files were originally coded as BVAR (Benning Variable n) data, but were changed to more descriptive terminology for this study. For example, BVAR nn might have

been recoded to AIR for air pollution data. Additional files include military data from existing files and the terrain analysis study (US Army Engineer Topographic Laboratory 1976) and various derived files for the allocation process. A complete listing of files, by type and name, can be found in Tab 1 to Appendix B.

27. Many of the existing BVAR files were found to contain inaccurate data; these were corrected where possible. Also, new information was added to files to the greatest extent practicable in order to provide Fort Benning with a total data base. In those cases where timber stands were inventoried and digitized as part of this study, but were later changed through ongoing management practices, the updated data were not always included in the data base. These will be noted under separate cover to allow Fort Benning personnel to readily identify those areas for updating.

28. Data are generally arranged on the basis of training/range compartments. Additionally, some data, such as timber and wildlife, are available on both a stand and regional (sectional) basis, while data used in the allocation process are generally on a regional basis.

29. A file is named on the basis of where and what it is. For example, timber data by forest type for compartment M11 would be name M11TBRFT; gray squirrel HSI data for the Northwest region would be NWGSQHSI. In all cases the name is meant to give the user an idea of what the file contains.

General allocation process

30. Guiding principles for developing the prototype allocation process included the concepts of multiple-use management (and thus multiple allocations), spatial and thematic balance across the installation, and environmental stewardship. Furthermore, the established procedure must be dynamic, comprehensive, and easily integrated into installation management philosophies.

31. After initial data gathering and construction of basic inventory maps, integrated parametric maps were constructed to aid in preliminary allocations based on five major themes:

a. Endangered and threatened species protection.

b. Preservation of archaeological and historical sites.

c. Management of potential commercial forests.

(1) Loblolly pine (*Pinus taeda*).

(2) Mixed pines.

(3) Mixed pines and hardwoods.

d. Management of wildlife habitat.

e. Maintenance of military training.

32. Although Fort Benning's fundamental mission is to provide military training, the natural resource and cultural themes were given first attention since training occurs throughout the installation. Because there are numerous potential conflicts between military and non-military activities, military allocations were made independently.

33. The actual allocation process is three-tiered: (a) an initial phase that results in preliminary allocations for natural resources, (b) a second phase that focuses on allocations of military training requirements, and (c) a final phase that resolves conflicts between the military and natural resource requirements and assigns final allocations.

34. Initial phase: Natural resource allocations. The first step in this phase was to make allocations among natural resource requirements by considering each theme separately and independently of other themes. Criteria for spatial and environmental allocation of each them were established; site suitability analysis was then applied. Allocation of land uses and activities was made on the basis of environmental or other associated factors, regardless of potential problems or conflicts that could arise. These allocations included all that could be accommodated within a compartment. The principal problems were those typically encountered in resource analysis projects, e.g., deciding proper criteria, deriving satisfactory support data, and classifying the various components. Attention then focused on synthesizing these allocations by uniting all of a compartment's allocations and then deciding which were compatible. The basic working premise was to retain as many uses in a compartment as possible. However, a holistic synthesis was needed to maintain environmental quality, proper spatial distribution of uses, and thematic balance.

35. The second step in this initial decision-making phase was to allocate on the basis of "primary" and "secondary" uses. Ordinarily, "primary" referred to the most suitable use that should be allocated to a compartment, whereas "secondary" denoted lesser suitability. These allocations were based on factors such as forest type, site index, and age. The terms "primary" and "secondary" were used throughout the process to help track allocations and to guide balances. An attempt was made to maintain only one primary

activity per compartment to avoid confusion; however, several compartments were given two compatible primaries. Each primary activity received equal and major attention.

36. After allocation of primary activities, only secondaries that were compatible with these primaries were retained, resulting in each compartment supporting a primary and a set of secondary allocations. For example, if endangered species protection was the primary allocation, then non-destructive activities, such as other wildlife habitat management activities, may be the only secondaries considered. An excerpt of the table used to chart these initial allocations is presented in Table 1. NOTE: Table 1 was also used in the second phase to chart military allocations. Therefore, it contains some references to military activities.

37. Second phase: Military allocations. Military resources are different in concept and type from environmental resources and therefore allocation of military resources required a distinctly different approach. Whereas most environmental factors are physically linked, i.e., controlled by associated natural processes, military components are not necessarily related by common or similar processes or reasons. Features that exist in one area may have relation to features of adjacent sites. Because of this lack of functional linkage, military maps were constructed primarily as basic inventory maps or simple combinations of military features. Additionally, elaborate manipulations that were used to assemble the natural resource data base were not necessary in this phase.

38. Information was generally lacking on the environmental requirements for the types of training that occur at Fort Benning. Consequently, selection of environmental criteria for training had to be developed prior to constructing maps for allocations. The scheme matched existing vegetation, relief, roads, stream fords, etc., with typical and probable needs and activities of various training operations. Compartments were assigned primary or secondary training allocations based on these data.

39. Military maps showing locations of selected features of military importance and environmental properties were recoded for military relevance. They contained pertinent features that were needed in the preliminary military allocation process. Each map had data from one or more inventory maps that were grouped into convenient military categories. Some diverse but related data were combined into single maps for convenience. The basic procedure used

in this step, following construction of the necessary files and maps, was to visually assess each compartment thematically and decide the most appropriate code assignment. These assignments were based on suitability guidelines developed for three levels of training: heavy (unit vehicular), moderate (unit foot), and light (individual infantry).

40. For heavy training activities, environmentally sensitive sites and compartments were eliminated before evaluating lands for heavy-duty allocations. Primary components considered in this allocation included:

a. Soil erosion.

b. Slopes.

c. Road access.

d. Open land.

e. Stream bank slopes.

41. The procedure for moderate-activity allocations (equivalent to infantry foot training) were similar to those of heavy-duty activity allocations except that different files were used. In place of soil erosion, slopes, and road access, etc., the following information was used: concealment from air, concealment from ground, and cover from flat trajectory of small arms.

42. Light training activities were allocated to all compartments due to their minimal impacts. However, certain special requirements that were considered during conflict resolution included the presence or absence of special individual training courses, such as bayonet, hand-to-hand combat, and physical training areas.

43. Third phase: Final conflict resolution. Because the military and natural resource assessments were made independently, conflict resolution techniques were applied to resolve incompatibilities, to refine allocations, and to aggregate on a regional basis. Each compartment's data were analyzed in detail to make comprehensive regional allocations. Table 2 shows compatibilities between the military and natural resource allocations shown in Table 1 and examines their frequency of occurrence within each compartment and for the region. A list of caveats affecting compatibility is included within Table 2.

44. To insure multiple use, a process of "exclusion" was used, i.e., all allocations remained unless a case for exclusion was made. This type of process was used in lieu of elaborate justification for compatibility with all

other allocated uses. Compartments with predetermined or fixed uses were identified first. These specialized compartments were classified as either "exclusives" or "potential exclusives," as defined below.

a. Exclusives. Some compartments have exclusive uses, such as those with firing ranges, impact areas, or housing areas, which are incompatible with most other military and natural resource activities. These should be identified and delineated accordingly, essentially making them off-limits for other allocations. Also, the presence of features that cannot be readily changed will influence the allocation of that compartment. For example, the presence of elaborate training structures (e.g., obstacle courses that may be impractical to move) suggest that the compartment be allocated to individual infantry training, although other uses may be assigned if they are compatible.

   Additionally, because of environmental or spatial constraints, some compartments may not be suitable for particular types of activities. These should be excluded at the beginning, before allocation decisions are considered. For example, swamp areas are not suitable for tank training; these areas should probably be allocated to dismounted infantry training. Also, compartments adjacent to cantonments (housing areas) obviously are not appropriate as impact areas or vehicular driving ranges.

b. Potential exclusives. Other compartments may have environmental or military attributes that warrant consideration as a "potential exclusive" classification. For example, a compartment composed mostly of very young pine (0-10 years old) should be left idle to allow the pine to mature; this action potentially makes it an "exclusive" compartment.

   These compartments should be identified and set aside for special attention in the allocation process. If unable to allocate as a single-use or single-theme compartment, interference with the compartment's primary purpose will be minimized in the allocations.

45. One possible conflict resolution strategy used when there were incompatibilities, especially in the "exclusive" and "potentially exclusive" compartments, was to consider subdividing compartments. This involved reducing compartments into unique and inviolate areas (or special sites), which were considered independent of other allocations. Using the fragile young pine example above, there may be too much competition from other potential uses in the compartment to designate the entire compartment "exclusive" for pine management. If the young pines existed in a distinctive section, subdividing the compartment would delineate the section as a separate allocation entity. Thus, the young trees would be effectively protected while allowing other uses in the remainder of the compartment. Obviously, the

creation of subcompartments depends on favorable spatial distribution (e.g., aggregation) of the pines and will not work if they are scattered throughout the entire compartment.

46. The compatibility matrix (Table 2) was compared to the preliminary compartment allocations (Table 1). A short series of questions was addressed for each compartment in order to construct the semi-final allocation table (Table 3). These questions were as follows:

a. If there is only one primary, is it a rational allocation? For example, if a compartment is allocated for mixed pine and hardwood management but has a very high site index for loblolly pine, should the compartment be reallocated to loblolly pine management? Because subcompartments do not share allocations, this process normally will be unnecessary for them.

b. Are all primary allocations compatible with each other? It is possible that a fundamental incompatibility exists, e.g., unit vehicular training and endangered species allocations. The most obtrusive or detrimental primary allocation should be excluded, based on the nature of the potential secondaries. In this example, if most of the secondaries are forest- or natural-resource-oriented, perhaps a wildlife allocation should be kept at the expense of the military allocation.

c. Are all primaries compatible as primary allocations? Although several activities may coexist, they may not be compatible as the major allocations. One primary may need reallocation as a secondary or should be excluded. For example, a compartment is given two primary allocations; one is a special military training site (e.g., a bivouac site) and the other is unit vehicular training. These activities are possibly compatible if unit vehicular training is not conducted within the designated bivouac site and is reallocated as a secondary activity for the compartment. The resource manager has to decide which activity takes precedence.

d. Are all primaries compatible with the secondaries? To optimize the multiple use of each compartment, the initial goal is to allocate as many activities as possible. Normally, primaries take precedence and all incompatible secondaries should be excluded. However, judgement may be needed for some cases. For example, if the single primary activity is incompatible with multiple secondaries, perhaps the primary should be excluded to preserve an optimum number of secondary uses. Also, a primary activity's priority may interfere with the secondary activities but, by reallocation from primary to secondary, conflicts may be avoided. Major reevaluations should be avoided if possible, although they may be necessary for successful conflict resolution.

e. Are all secondaries compatible with each other? Consideration of the nature of the primary activities as well as that of each secondary is necessary. The most detrimental secondaries

should be excluded. Timber harvests, for example, should not occur within designated archaeological or historical sites, unless non-destructive harvesting techniques are used. If these activities still conflict, then timber harvests should be excluded to preserve the archaeological/historical sites.

47. To insure an acceptable range of allocations, a quick assessment of the balance between natural resource and military primary allocations was completed. Tabulation of each compartment's primary and secondary allocations was made, providing a suitable overview of the results.

48. The final steps involved review and confirmation, or change, of the regional allocations, followed by "stitching" regions into an installation-wide coverage for review. This afforded a useful perspective to assess the distribution of allocations, which may have revealed a need to redistribute allocations. This was an iterative process that took several cycles of readjustment to finalize. Once allocations were finalized, definitive maps were produced.

LANDMENU

49. The second major part of the land-use planning methodology developed for TRADOC is that of LANDMENU. LANDMENU is a computer system written in dBASE III PLUS designed to summarize inventory data into natural resource information compatible with the needs of an Army installation forestry program as well as with an installation-wide land-use allocation system. This system processes forestry and wildlife habitat data collected by field crews, develops stand characterization information, reports these summaries, and provides a means to forecast stand conditions for comparing alternatives.

50. There are basically five major functions in the LANDMENU system. These are: (a) input and editing of field data; (b) calculation of HSI's for five wildlife species; (c) calculation of "reconnaissance level" timber volumes; (d) simple forecasting of timber stand conditions; and, (e) development of pertinent reports.

Field data input and editing

51. LANDMENU is based on field data collected on timber and wildlife habitat variables. The timber variables were derived from the CISC process while the wildlife habitat variables came from the HSI models. Certain variables from the CISC were replaced (i.e., cut and leave basal areas for pines

and hardwoods) by similar variables needed in the HSI model (i.e., tree species and tree diameters for all trees measured on each plot).

52. Field data were collected by two-person crews following predetermined cruise lines through each compartment. Cruise lines were established by starting at identifiable air photo features that could also be recognized on the ground, and continuing in straight lines through representative vegetative conditions until a convenient, identifiable turning point was reached. At regular intervals along these lines, sample plots were established and appropriate timber and wildlife habitat data were collected. Location data were recorded at each plot (i.e., compartment identification, cruise line number, and plot number) to permit later assignment of plots to forest stands for characterization summaries. Approximately 3 percent of each compartment was sampled.

53. At each sample plot, crews collected data on diameter and species of each tree selected by a 10 sq ft/acre basal area factor wedge prism. Data on overall timber stand conditions (i.e., stand condition class, forest type, proposed management type, etc.) were also recorded. Tree age and total height data were collected at selected plots in order to adequately characterize stand age and site index information. Wildlife habitat variables were also sampled at each plot (i.e., percent cover of herbaceous winter deer browse species, percent cover of herbaceous bobwhite quail foods, presence or absence of woody plant species that produce fleshy fruits, etc.).

54. Field data were recorded on field data sheets, which were initially summarized by hand in the office to delineate forest stands according to similar species composition, stand condition class, tree stocking levels, and stand age. The data sheets were then forwarded to WES for keypunching and editing.

55. Field data were entered into three dBase III Plus files for each compartment. First, the "header" data (i.e., compartment, line, and plot), the timber stand condition data (i.e., stand condition class, forest type, etc.), and the wildlife habitat data from each plot were placed into a file called "COMP???.DBF." Second, tree species and diameter data were placed into a file called "SPEC???.DBF." Third, the compartment prescription summary (i.e., a stand-by-stand summary of the major aspects of each stand -- this includes stand acreages determined by digitizing stand maps) was entered into

a file called "ACRE???.DBF." In all cases above, the "???" stands for the appropriate compartment designation such as 015 or D06.

56. These data files were "backed up" or duplicated on floppy disks and on hard disks of several microcomputers used by the project. In addition, the original data sheets have been filed and stored for later use if necessary.

57. More specific details concerning the sample procedures used are included in Appendix A, and in-depth discussions of the LANDMENU system and data entry and editing routines are included in Appendix C.

Habitat suitability indices

58. As previously noted, the white-tailed deer, eastern wild turkey, eastern gray squirrel, bobwhite quail, and red-cockaded woodpecker were selected for management by Fort Benning personnel. The first four of these species were chosen because they are important as game animals, while the last species was chosen because of its sensitive legal status. The emphasis of this project was habitat management since population regulation is primarily a state responsibility. Also, populations are ultimately dependent on suitable habitat conditions for their survival and prosperity.

59. One of the study objectives was to assess the potential value of an area as habitat for the various species. The approach was to utilize HSI models as starting points for species life history requirements and modify these as necessary to develop a set of habitat variables common to as many species as possible. These common wildlife habitat variables were then compared to required forestry variables, and both groups were adjusted to arrive at a set of variables that would maximize the total information gathered with the minimum effort. Certain forestry and wildlife components could not be combined in this manner. For these situations, selected variables had to be included as additional items in the sampling scheme.

60. The HSI calculations follow the HEP format of comparing the sampled values of habitat variables to optimum values for these variables as determined from the published literature or from expert judgments provided by authorities on each particular species. These scaled values for each variable, or suitability indices as they are known in HEP, are then combined in a formula that reflects the relative importance of each variable to the overall habitat suitability of particular area for a given species (i.e., the HSI).

61. An HSI was calculated for each species in each of the stands. These HSI's were reported by stand along with various interim values used in

the calculations (i.e., average cover values for winter deer browse and quail foods, etc.). A compartment HSI, weighted by acreage, was also calculated for each species.

62. As noted above, the HSI's reflect the potential value of an area to a given wildlife species. The population levels of a target species may not agree with the HSI for a number of reasons. This circumstance could be due to abiotic factors such as local weather fluctuations or climatic cycles which override the habitat factors, or it could be due to biotic factors such as competition or disease which keep the population below carrying capacity.

63. A detailed discussion of the models used, the model modification procedure, the variables used, and the rationale behind these items is included as a part of Appendix A.

Timber volumes

64. Timber volumes in board feet (Scribner rule) and cords have been calculated for each forest stand. These are considered as "reconnaissance level" volumes and are designed to provide an overview of the installation's timber resources.

65. The inclusion of tree species and diameter measurements in the forestry sampling procedures allowed for the creation of stand tables (i.e., numbers of tree stems by diameter classes and species groups) which in turn were used to calculate an estimate of the volume in each stand. The number of tree stems in each cell of the stand table was multiplied by an average volume figure for an individual tree in each diameter class to give the volume estimates.

66. Average volume estimates for each diameter class were developed from a local volume table calculated from harvest data at Fort Benning. This local volume table was based on approximately 68,000 sawtimber-sized pine trees (12 in. in diameter at breast height (dbh)), approximately 8,500 sawtimber-sized hardwood trees (12 in. dbh), and on approximately 128,000 pulpwood-sized pine trees (6-10 in. dbh). The table was based only on diameter classes since merchantable tree heights were combined for each diameter class.

67. These timber volumes are considered "reconnaissance" level for two reasons. First, the stand tables are based on the expansion of prism plot data that were designed primarily to delineate forest stands and not to estimate timber volume. It has already been noted that the inventory procedures used at Fort Benning prior to this study did not include tree species and

diameter as variables. These variables were added to the sampling scheme by WES primarily to provide data needed in some of the HSI models, and as an added benefit, to provide a means of estimating these "reconnaissance" volumes. Second, the local volume table is based only on the two broad categories of "pine" and hardwood," and thus does not have the necessary detail for sophisticated timber volume estimates.

Forecasting timber stand conditions

66. LANDMENU includes a simple routine for forecasting present timber stand conditions into the future. This procedure is based on the concept of stand table projection, and will provide summary data on basal area, volumes, trees per acre, and estimated harvest volumes.

69. This forecasting routine begins with the current stand conditions (i.e., as of the most recent sample) and allocates diameter growth and mortality to the existing trees to derive an estimate of future stand conditions by 10-year cycles. Currently, the system calculates and reports this information in general terms (i.e., volumes for "pines," and for "hardwoods") in keeping with the level of detail of the original data. With some modest modifications, however, the system could be refined if the forestry sampling is upgraded to provide local growth and mortality data along with more species-specific volume data.

Reports

70. Once the initial stand and compartment calculations are completed, LANDMENU provides an extensive reporting capability. Compartment summary information is saved in a number of dBase III files and is available for immediate or delayed output. One entire section of the system is dedicated to reports and report formats. Detailed guidance on how to access reporting capabilities is provided in Appendix C.

PART III: MANAGEMENT OBSERVATIONS AND RECOMMENDATIONS

Overview

71. In this section, specific management recommendations are developed for Fort Benning. These are based on observations gathered during the course of the project and from the pertinent literature. Although these recommendations are oriented to the local needs of this particular installation, the management philosophy and approach behind them are applicable to all Army installations.

72. These recommendations are grouped into five subject areas: (a) soils, (b) forestry, (c) wildlife, (d) military training, and (e) alternative land uses. Detailed suggestions are given for the management of the respective resources that make up the first three subject areas, while observations that were made during the project are noted for the last two subject areas.

Interdisciplinary Coordination

73. In managing the natural resources at Fort Benning, it is imperative that the staff specialists for each discipline and the Natural Resource Manager develop and conduct a coordinated program. This should begin with setting program goals and objectives designed to optimize the benefit mix obtained from all resources. Next, the staff should list the various activities and programs proposed for implementation, and determine the potential impacts of these activities on the individual resources. Once these items are identified, the staff can begin a process of impact evaluation design to modify these activities to minimize conflicts and to maximize benefits. The final result should be a series of specific, coordinated guidelines for program implementation and monitoring.

74. This interdisciplinary approach is illustrated in the sections below. Soil resources are emphasized first due to their basic nature and the dependence of other resources on them. Forestry is discussed next because Fort Benning is primarily a forested installation. Wildlife is discussed third because the wildlife program depends on habitat manipulations resulting

from forest management activities. The order of presentation is logical, but all resources are of equal importance and should be managed as such.

Soils

75. Approximately 35 soil series occur at Fort Benning; these soils are grouped into approximately 88 soil mapping units on the basis of slope, degree of erosion, and occurrence by county. Soil maps, soil series descriptions, soil mapping unit descriptions, and interpretations for various uses were provided by the SCS for installation lands in Muscogee and Chattahooche Counties, Georgia, and for installation lands in Russell County, Alabama.

76. Given the above information, WES grouped these soils into 10 soil categories. These 10 categories were further combined to produce 6 soil management classes for natural resource management interpretations. These classes are based primarily on the site index concept as commonly used in forest management, with additional consideration being given to topographic position of the soil, and to inherent soil constraints, such as wetness, root-restricting layers, and deep sandy layers. These categories and classes are designed to enable the natural resource management personnel at Fort Benning to identify the major patterns on installation lands, and to identify the major opportunities afforded and constraints imposed by the soil resources.

Soil categories

77. Ten soil categories were developed from inspection of the soil maps, descriptions of soil series and mapping units, and the forestry interpretations provided by the SCS. These categories are based mainly on the topographic position and the forest growth potential of each soil series. The categories developed were:

a. Ravines.
b. Minor bottoms.
c. Major bottoms.
d. Swamps.
e. Terraces.
f. Upland, high potential.
g. Upland, medium potential (clay).
h. Upland, medium potential (sand).
i. Upland, medium potential (deep sandy).

j. Upland, low potential.

78. Soils were divided into three primary topographic classes: (a) floodplains or "bottoms," (b) terraces, and, (c) uplands. The topographic position of the site reflects two primary aspects of soil genesis and management. First, in the local Fort Benning area, the relative topographic position of a site is generally correlated with the parent material from which a given soil developed. Second, the relative topographic position generally dictates the water regime for a site.

79. The Fort Benning soils are derived mainly from old coastal plain material deposited when the sea level was higher than at present. These coastal plain deposits range from sandy to clayey, but are primarily sandy in the sandhills physiographic region where Fort Benning is located (Hodgkins 1965). As the area was dissected by erosion, the more resistant sands remained in place, thus becoming the present uplands. The less resistant clays, silts, and finer sands washed away were deposited in the drainages. As weathering continued, these alluvial sediments became the parent material for the lower lying soils. Floodplains developed and were abandoned by the continual downcutting action of the streams. Consequently, there are not recent floodplains (e.g., the "bottoms"), former floodplains (e.g., the "terraces"), and resistant sandy areas (e.g., the "uplands"). Thus, even though all of these soils came from coastal plain deposits, they are derived from different parent materials based on the extent of weathering and on their relative topographic positions.

80. Parent materials are the basic "building blocks" for soil formation, and soils derived from different parent materials often have significantly different properties even when they develop adjacent to one another under similar conditions. The inclusion of parent material (as generally expressed through topographic position) in the formulation of the basic soil categories helps to resolve major patterns in the use of soils data in the natural resource management program.

81. The second reason for including topographic position as a factor in the development of the basic soils categories is that it is important in relation to the water regime of the site. Topographic position affects the water regime in terms of infiltration of precipitation into the soil, run-off, headwater flooding, and backwater flooding. Generally, sites occurring on the lower landscape positions have more moisture available for plant growth than

do comparable sites on higher landscape positions. Also, the use and management of these lower lying sites may be limited as a result of their water budget; standing water, trafficability, and water quality considerations are potential constraints.

82. Conversely, sites on the higher landscape positions are normally drier and more subject to water deficits for plant growth than are sites lower on the landscape. Also, the sites on these higher positions are less prone to excess water that can constrain management activities. Relative topographic positions of each soil series or mapping unit were taken from narrative materials provided with the soil maps of Fort Benning.

83. Relative topographic position is, of course, only one consideration, and its impact may be overridden by inherent soil properties such as texture, structure, fertility, or profile development. Inherent soil properties directly impact the capability of a given site to support plant growth. For forestry purposes, the growth potential of a site is expressed as site index, or the height of a tree of a given species at a specified age (normally 50 years). Site index estimates for each soil series were taken from SCS interpretations supplied with the soil maps of Fort Benning.

84. Each of the 10 soil categories is discussed below. These discussions include the general rationale for designating each category, a brief description of the category, and broad recommendations for natural resource management on soils within each category. Data on the acreages of the soil series included within each category are summarized in Tables 4 and 5.

85. Ravines. These soils occur on the toe slopes and bottoms of ravines in the sandhill uplands. The ravines are generally at the head of drainage systems and are just below the upland soils and just above the soils of the minor bottoms. These soils are wet enough to be considered as hydric (i.e., soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part).

86. These ravines are valuable as hardwood stringers for wildlife corridors, and as sediment catchments between the uplands above and the stream bottoms below. These areas should be managed as streamside management areas with fire and timber-harvesting activities being excluded from them.

87. Minor bottoms. These soils occur along the lower, more recent portions of active floodplains and they are wet enough during some portion of the growing season to be considered as hydric soils.

88. As a general rule, these soils should be managed as streamside management areas with both fire and timber-harvesting activities excluded. However, when these soils occur contiguous to or with soils of the major bottoms, they may be incorporated into the management activities recommended for those areas. In all cases, special attention must be given to the wet nature of these soils and to their unique position in the landscape (i.e., immediately adjacent to active streams).

89. Major bottoms. These soils occur along larger streams and along the lower portions of smaller streams in the sandhills and coastal plain areas. These are the soils of the major floodplains of the area, and they generally occur above soils of minor bottoms and below soils of the terraces.

90. Areas having these soils should be managed primarily as streamside management areas. However, when these bottoms are large enough, they can be incorporated into an active hardwood forest management program as long as soil erosion, water quality, and wildlife habitat considerations are addressed.

91. Swamps. These soils occur in depressions and low areas on floodplains, and in old stream meanders at the base of upland escarpments. They are flooded or ponded to a depth of 1-6 ft for very long periods (30 days or more) during most years and are considered to be hydric soils.

92. Areas having these soils should be managed for wetland wildlife (i.e., waterfowl, amphibians, etc.) or preserved as natural areas. Prior to implementing any forestry or wildlife management activities that require water level manipulation, these areas should be surveyed for special, sensitive, or unique plants or animals. Areas having species or communities with special status should be recorded, marked, and managed to preserve these unique features.

93. Terraces. These soils occur on terraces immediately above the floodplain soils and just below the upland soils. They developed under floodplain conditions, but are now above normal flooding levels due to the downcutting action of streams which has resulted in the development of lower, more recent floodplains.

94. These soils represent a physical transition between the floodplains and the uplands, which is reflected in the management recommendations for these areas. Terrace soils are generally well-suited to either hardwood or pine management. Site indices for both pines and hardwoods are high (loblolly

= 90; sweetgum = 90; yellow poplar = 95-100). Consequently, terrace soils can be managed for pine, pine-hardwood, or hardwood forest types.

95. The first factor to be considered for management should be the proximity to an active stream channel; any management activity implemented should insure the maintenance of an adequate streamside buffer. The second factor considered should be the relative mix of existing and planned forest types within a particular compartment or group of compartments. An adequate balance of hardwood forest types should be maintained in all compartments; in some instances, this may only be possible by managing for hardwood or pine-hardwood types of terrace soils. The third factor to be considered should be the need for high-quality sites for pine management. As long as the first two factors above are adequately considered, these high-quality terrace soils should be favored for pine management. Whenever possible, these terrace sites should be combined with high-quality upland sites to form the core of the pine management program on the installation. Intensive management on these limited high-quality sites should provide maximum returns for the management efforts invested.

96. Upland, high potential. These very gently to gently sloping soils are on broad areas, depressions, ridgetops, and hillsides in the uplands of the Southern coastal plain. In most instances, these soils should be designated for intensive pine management. These soils have high site indices for loblolly pine (SI = 90-95) and they are essentially the only upland soils with these high site indices on Fort Benning. These soils should be combined with appropriate terrace soils to form the core of the intensive pine management program on the installation. Every effort should be made to include and retain these soils under an intensive management program.

97. It is essential that these soils be adequately protected from erosion in order to maintain their high productivity. All silvicultural and military activities should be modified as necessary in order to preserve the integrity of these high-quality soils.

98. Upland, medium potential (clay). These very gently sloping to sloping soils occur on ridgetops, hillsides, and toeslopes on uplands in the Southern coastal plan. They have medium potential for pine management (loblolly SI = 78-82; slash SI = 80-82; longleaf SI = 66), but they may have some natural constraints. Permeability of the subsoil is slow to very slow,

and the root zone may be somewhat restricted due to the firm to very firm clayey subsoil.

99. These soils have a thin sandy surface layer over thick, clayey subsurface layers, and the erosion potential is high. Approximately 25,000 acres of the total 30,000 acres of the Nankin soils occurring on Fort Benning are classified as "severely eroded," and the remaining acreage in this category is potentially subject to similar problems.

100. These soils are best-suited to medium-intensity pine management. Although their potential productivity is moderate, they should contribute significantly to the overall forest management program as along as they are protected from further erosion. It is imperative, however, that these soils be protected from further erosion if they are to remain as assets for management.

101. Upland, medium potential (sand). These very gently sloping to sloping soils occur on broad to narrow ridgetops and short hillsides on uplands in the Southern coastal plain. They have medium potential for pine management (loblolly SI = 82-83; slash SI = 80-92; longleaf SI = 72-76), but they are subject to drought. All of these soils are classified as arenic; that is, they have sandy surface layers ranging in thickness from 20 to 40 in. Given this potential constraint, they should be combined with the upland medium potential (clay) soils in a medium-intensity pine management program featuring loblolly pine.

102. Upland, medium potential (deep sand). These very gently to gently sloping soils (Troup series) occur on ridgetops and on short hillsides on uplands in the sandhills. They are rated as medium for pines with site indices of 82 for loblolly and 74 for longleaf pines. These soils are potentially subject to serious droughtiness as they have 40 to 80 in. of sandy surface/subsurface layers in their profiles, and thus are classified as grossarenic soils.

103. The soils in the Troup series are best suited to pine management. Although loblolly will grow on these sites, longleaf is recommended due to the potential for droughtiness of these soils. The intensive management of loblolly and/or slash pine probably would not be nearly as efficient on these sites as it would be on the better sites.

104. Upland, low potential. These very gently sloping to moderately steep soils are on ridgetops and hillsides on the uplands of the Southern coastal plain. They have low potential for pine management (loblolly SI = 75;

slash SI = 70-77; longleaf SI = 60). Three of these soils (Ailey, Cowarts, and Vaucluse) have shallow root zones due to firm/brittle subsoil layers that are very hard when dry. The Lakeland series consists of deep sands throughout the profile and is excessively drained and droughty. The Blanton series has a deep, sandy surface layer (i.e., it is gross) and is moderately well-drained and may be droughty at times.

105. Areas with these soils should be excluded from active forest management, or subjected to very low-intensity management at the most. The scrub oak forest type (blackjack, bluejack, turkey oak) is best suited to these sites and should be retained wherever it currently exists, and re-established wherever possible. Also, the longleaf forest type may be a feasible alternative for a number of these sites, especially as potential long-term habitat for the red-cockaded woodpecker.

Soil management classes

106. Six general soils management classes were developed from the 10 soil categories (Table 4). The purpose of the classes is to provide a general overview of the forest management potential of the Fort Benning installation lands based on the capability of the soils to support these activities. Soils with similar capabilities and similar constraints were grouped. These classes are broad, but provide a "big picture" of the resources and constraints with which natural resource management personnel must deal. These classes are listed and discussed below.

107. Streamside management areas. This class includes the soils in the ravines, minor bottoms, and swamps soil categories. All of these soils are immediately adjacent to active streams and are sensitive resources. The ravine soils occur as long, narrow corridors along small drainages through the uplands. These soils generally have much higher site indices than the adjacent upland soils, but they are too small to delineate for pine management. The minor bottoms soils occur as long, narrow corridors along small streams in the uplands, and as wider flats in the first bottom portions of larger streams throughout the installation. These soils also have high site indices, but they are generally too small for inclusion in pine management areas. The swamps soils are much too wet for inclusion in any timber management program.

108. All of the soils in this class are hydric soils, and these areas meet at least one of the three criteria for an area being classified as a

wetland. If the hydrology and vegetation criteria are positive, these areas will classify as wetlands and be subject to the Section 404 regulations of the Clean Water Act.

109. The best use for soils in this category is to support plant communities that function as streamside management areas. These areas should protect the integrity of the adjacent streams and drainages from soil erosion and water quality degradation. Active timber management in these areas is impractical due to the fragmented nature and dispersed occurrence of these soils. Although these soils generally have very high site indices, they represent such a small part of most compartments that the total volume of timber production contributed would be insignificant when compared with the potential detrimental impacts that would be caused by the harvesting operations and subsequent loss of vegetative cover and soil litter layers. Also, these streamside management zones should contribute wildlife habitat values as "hardwood stringers" to serve as travel corridors and feeding/escape cover for various wildlife species such as the eastern gray squirrel, the northern bobwhite quail, and the eastern wild turkey.

110. Bottomland hardwoods. This class is synonymous with the major bottoms soils category. These soils currently support and should be maintained as bottomland hardwoods. They have high site indices for both pine and hardwood tree species, but the hardwoods should be retained on these sites for biological diversity. Less than 3 percent of the entire installation has the potential to support these "extensive" hardwood forest stands, but if a hardwood timber management program is contemplated for Fort Benning, these soils are capable of supporting it. Site conversion to pine stands should not be practiced.

111. These bottomland hardwood stands are extremely valuable as wildlife habitat, both inherently and as a result of their relative scarcity. These soils are also somewhat dispersed throughout the installation and the interspersion and juxtaposition values of the plant communities that they support are high for most wildlife species.

112. Pine management, high potential. This class includes those soils categorized as terraces and upland, high potential. Both of the categories contain soils that have relatively high site indices for pine tree species, and do not have any major constraints that cannot be overcome adequately. These soils should therefore form the basis of the "core" lands for pine

management on the installation. These soils represent the highest potential for pine saw-timber management that exists on Fort Benning. They should be dedicated to this use and protected, if possible, for competing resource uses such as military firing ranges, drop zones, etc.

113. Most of the acreage in this class comes from the terrace soils category (11,499 acres) which can support either pines or hardwoods. As long as the previous two classes are managed as recommended, these terrace soils can be dedicated to pine forest types without any significant detrimental effects on the overall wildlife program of the installation.

114. Because of the high site indices for hardwood species on the terrace soils, the concept of pine-hardwood management types may be a desirable alternative for them. With these high site indices, some hardwood trees are going to grow vigorously and invade these stands. When this happens, it may be better to select the best hardwood trees of desirable species and grow them as "crop" trees rather than to try to eliminate them from the stand in a wholesale manner that would require significant expenditures of time and money.

115. The upland, high potential sites are relatively scarce (only 4,314 acres total), and because of this, they should be dedicated to pine management.

116. Pine management, medium potential. This class includes the soils in the upland, medium potential (clay), and upland, medium potential (sand) categories. These are upland soils that have site indices somewhat lower for pines than do the soils in the previous class. These soils are best suited for intensive management of pine forest types with the understanding that their potential productivity is "average." These soils should be combined with the previous class to form the core lands for the intensive timber management program at Fort Benning. In terms of long-term capability, these two classes represent the major potential for loblolly pine management.

117. Although these are average or medium sites for pine growth, pine trees may actually grow better here than at the more productive sites due to the probability of less competition from the hardwood trees, which should be growing more slowly on these sites.

118. Three soils series in this class have clayey subsoils with sandy surface layers that are highly subject to erosion. The Esto and Susquehanna series are currently in relatively good shape at Fort Benning, but the Nankin

series has extremely serious problems. Over 80 percent or roughly 25,000 acres of these Nankin soils are mapped as "severely eroded."

119. Every effort should be made to insure that these soils are managed properly since many of them occur on relatively steep slopes where erosion forces could be high. An adequate litter layer should be maintained on these soils at all times in order to limit their exposure to soil loss from direct precipitation. Also, the harvesting and site preparation techniques used (including location of logging decks and skid trails, the sequence of harvesting adjacent stands, and the seasonal timing of harvesting individual stands) should be guided by the principle of minimizing the exposure of these soils to runoff and erosion. If these soils are not managed properly, they could lose their productivity for forest management and become natural resource liabilities that would divert funds from desirable programs into costly restoration projects.

120. Given these cautions as incentives, the standard use of the "clear-cut, site prep, and replant" system of even-aged forest management should be seriously questioned for use on these "severely eroded" soils. Instead, an even-aged system utilizing shelterwood cutting, or an uneven-aged selection system may be more appropriate.

121. The remainder of the soils in this class are sandy soils. These soils are medium or "average" in their site indices for pine trees, but they have the potential limitation of being subject to droughtiness. All of these series (except for Cowarts) are arenic, which means that they have roughly 20-40 in. of sandy surface layers in their profiles.

122. The Cowarts-Ailey complex typically consists of 35 percent Ailey soils and 55 percent Cowarts soils. These series were not separated at the mapping scale used, and must be separated on a case-by-case basis in the field. The arenic Ailey series was placed into this class, while the Cowarts series was placed into the upland, low-potential class (discussed below).

123. Longleaf pine management areas. This class includes only the Troup series, which was placed into a special category of soils designated as upland, medium potential (deep sand). These soils are medium or average in their site indices for pine trees, but they have the potential limitation of being particularly subject to droughtiness.

124. The Troup series is classified as grossarenic with 40-80 in. of sandy surface layers in its profiles. These relatively deep sands will be

subject to water deficit conditions more frequently and possibly more severely than will soils having higher water storage capacities. Because of this circumstance, longleaf pine should be better adapted to growth on these sites than loblolly or slash pine and should be the target species for forestry management on sites having these soils.

125. Scrub hardwoods/longleaf pine areas. This class includes those soils in the upland, low-potential category. These soils are either shallow due to inherent root-restricting layers or they are extremely droughty because they consist of deep sands. They also have low-to-moderate site indices for pine trees. The "scrub oak" plant community and longleaf pines are naturally adapted to these sites, and can tolerate these droughty conditions.

126. Loblolly and slash pine stands may grow on these soils but their growth rates will not be high. Instead of managing for loblolly and slash pines on these soils, efforts should be concentrated on those soils that will provide a higher return for the investment.

127. The soils in this class should be used to support scrub hardwood stands wherever they currently occur or wherever they can be re-established. Also, these soils should be used to support longleaf pine stands whenever possible. Both of these forest types have generally high wildlife values and they can be managed to improve these values while at the same time improving stand conditions that enhance the value of the areas for military training.

128. The scrub hardwood type, for example, is valuable as a high-quality food source (i.e., acorns) for the eastern wild turkey when the trees are mature. At this stage, these stands have reasonable high canopy closure values with relatively open understories; this translates into good concealment from aerial surveillance with adequate fields of view for ground observation and fields of fire for ground units.

129. In like manner, the longleaf pine forest type can provide similar benefits. Open-grown longleaf stands that are burned regularly on a prescription cycle will have widely spaced trees with relatively open, herbaceous understories. These stands will also provide concealment from aerial observation, good fields of fire, and excellent wildlife habitat values. In this case, these stands would serve as high quality habitat for the bobwhite quail, the eastern wild turkey, and the red-cockaded woodpecker.

130. In the case of the longleaf pine stands, both in this soils class and in the previous class, there is an excellent opportunity for implementing

multiple-use management that includes natural resources and military training objectives. Basically, these stands should be maintained or re-established as the longleaf pine management type with even-aged, long rotation (100-120 years) management. Timber harvesting operations such as periodic thinning should be employed primarily to maintain these areas as open, park-like stands with regularly burned understories. Emphasis should be given initially to re-establishing and maintaining good stocking levels of longleaf in as many areas as feasible. Once this is accomplished, a major portion of the installation would be producing moderate levels of high-quality longleaf sawtimber on a continuing basis while simultaneously providing military training and wildlife habitat benefits. Virtually all of these longleaf management areas would be functioning as potential habitat for the red-cockaded woodpecker under long-rotation, even-aged management.

131. Under this scenario, intensive management primarily for loblolly pine could be practiced on the best pine sites throughout the installation. Only minor modifications would then be needed in the management of these high value pine sites to allow for the endangered status of the woodpecker.

Soil conservation

132. The conservation of these soils resources is critical to the long-term effectiveness of the natural resource management and military training programs at Fort Benning. Program organizational and staffing recommendations designed to ensure the conservation of these soil resources are presented in Part IV below.

133. The details of implementing field techniques for soil conservation are not presented in this report. The reader is referred to an excellent discussion of best management practices (BMP's) for silvicultural activities (Florida Division of Forestry 1987a,b) designed to comply with Section 208 requirements of the Federal Clean Water Act. Additional information and assistance is available from the Georgia Forestry Commission, and from the SCS.

Forestry

134. The Fort Benning Military Reservation consists of 182,000 acres of primarily forested lands occurring in the sandhills region of the hilly coastal plain province (Hodgkins 1965) of west-central Georgia. The

installation supports mainly the southern yellow pine forest types on the uplands, with lesser amounts of mixed pine-hardwood and scrub-hardwoods also on the uplands, and bottomland hardwoods in the drains and stream bottoms. Specific forest types and their approximate acreages are given in Table 6.

Goals and objectives

135. The forest management program is the driving force for the overall natural resource management program at Fort Benning. The installation is primarily forested and any modifications to the environment will necessarily be made mainly through timber harvesting. The forest management program must therefore be a multiple-use program that accommodates specific needs and objectives for all of the natural resources on the installation.

136. The overall goal of the program should be to provide an optimum mix of managed and natural habitats. This mix should be capable of producing timber, wildlife, water, and military training support benefits on a sustained basis in a manner that protects and enhances the long-term inherent productivity of the soil resources of the installation. Given this goal, general objectives are needed to guide the program toward its attainment. These objectives are: (a) determine current status, (b) specify the desired future conditions, and (c) make decisions on any appropriate course of action. With this approach in mind, the following specific objectives are recommended:

a. Conduct and maintain a comprehensive inventory of the soil resources, timber stand conditions, and wildlife habitat conditions of the entire installation.

b. Regulate the forest by appropriate productivity classes, and develop geographical management zones and coordinated management recommendations for featured wildlife species.

c. Develop mid-term management plans and annual work plans to provide specific guidance for budget and manpower needs and program implementation.

Natural resources inventory

137. This requirement has been accomplished with the completion of this study. Forest compartments have been delineated into stands based on forest type, age, and condition class. Stands have been further characterized by additional timber and wildlife habitat features that provide a means for management groupings. Also, soils of the installation (exclusive of impact and cantonment areas) have been mapped by the SCS to Order-2 survey standards.

Soil management classes

138. The six soil management classes recommended in the soils section above will be the basis for recommendations made concerning the allocation of forest lands to various uses. This allocation is necessary as a preliminary step to the forest regulation process described below.

139. Those lands classified as streamside management areas and as scrub hardwood/longleaf pine areas are not included in the overall total of lands recommended for forest regulation. Lands in these two categories should be reserved for wildlife habitat due to their scarcity, their high value as prime habitat, and/or their low timber-producing potential.

140. The stands occurring on the soils of the remaining four soil management classes should be regulated in five timber-management working groups: (a) bottomland hardwoods; (b) high-intensity pine management; (c) medium-intensity pine management; (d) longleaf pines; and (e) pine-hardwoods. By separating the classes at this level, the regulated forest will reflect the capabilities and limitations of the various sites occurring at Fort Benning.

Forest regulation

141. The primary administrative goal of the forestry program must be to regulate the forest. This means to organize the age and size classes of the trees present in a proportional manner such that they will consistently yield a regular annual or periodic harvest of forest products on a perpetual, sustained basis (Davis 1966). this is necessary in order to insure continuity and stability in forest management.

142. Forest regulation can be maintained using area control, volume control, or a combination of both, as applied to stands of even-aged or uneven-aged timber. However, the age class distribution of the entire forest must first be brought into a proportional balance. If this is not done, the flow of harvested products will be uneven at best (e.g., cutting some unknown percentage of the surplus of growth produced at irregular intervals as stands become old enough to harvest) to damaging at worst (e.g., inadvertently harvesting more than the surplus of growth and consequently liquidating the growing stock). It is therefore essential that the current distribution of age classes be known; once this information is available, management personnel can begin to bring the age classes into balance.

143. The approach used in developing the recommendations for regulating the forest at Fort Benning was to:

a. Determine the "gross" acres available within each soil management class;

b. Determine logical forest management working group designations that correspond to the capability of the sites within each soil management category and that meet overall installation needs for timber production and biological diversity;

c. Allocate working groups to appropriate soil management classes;

d. Determine estimated "net" acres for each working group by deducting approximately 15 percent from the gross to compensate for miscellaneous uses (i.e., interior roads, military sites, etc.);

e. Determine available "rotation" acres for each working group by deducting approximately 10 percent of the net acreage to be set aside and managed as "old growth" forest stands (designed to serve primarily as baseline habitat for red-cockaded woodpecker colony sites);

f. Determine a desired age class distribution for each working group by dividing the "rotation" acreage figure by the appropriate rotation length in years. This value, the number of acres that should be in each 1-year age class, is then multiplied by 10 to get the acreage in each 10-year age class;

g. Determine the present (or actual) age class distribution for each working group;

h. Develop a regulation progress table for each working group that displays the number of acres, by age classes, to regenerate during each cutting interval in order to achieve the desired age class distribution.

144. Steps a. through f. in this process are summarized in Table 7 and the recommended age class distributions for the four primary timber-producing working groups at Fort Benning are given in Table 8.

145. Step g., determining the actual present age class distribution, is somewhat complicated because of the need to incorporate stand-specific soil data in the tabulations in order to achieve the long-term goal of matching vegetation to site productivity. The present occurrence of a specific forest type on the ground may not necessarily correspond to the soil management class recommended for a given working group.

146. This problem should be approached in three phases. First, individual forest types should be tentatively allocated to one or more working groups (Table 9) based on biological relationships between forest types and soil series, and on acreage figures derived from the LANDMENU database. Second, landscape patterns between forest types and soils should be checked

using the GIS to verify or modify the assignments made in phase one. Third, the preliminary list developed for each working group should be continually field-checked by management personnel during the prescription planning process. This will allow the flexibility needed to respond to opportunities presented by on-the-ground conditions that might otherwise be lost by a strict adherence to general guidance. For example, similar-sized stands in different working groups might be "exchanged" in order to preserve values associated with the existing vegetative conditions (age, species composition, location, etc.) even though the stand assignments based on soil conditions would normally dictate otherwise.

147. Regulation progress tables (step h.) were developed for the four primary timber-producing working groups. These are preliminary tables based on LANDMENU data as developed according to step g., phase 1 (as described above). Tables 10 through 13 present this information for these four working groups. The rationale behind these recommendations are given in the discussions of the various working groups below.

Determination of the cut

148. Table 14 summarizes the proposed annual timber-harvesting plan for Fort Benning based on the working groups and their respective desired age class distributions.

Rotation length

149. The rotation lengths are currently set at 80 years for loblolly pine (the predominant management species), and at 100 years for longleaf pine and the upland/bottomland hardwoods. These rotations are considerably longer than those currently advocated for industrial lands of somewhat similar quality (35-45 years for pine plantations for sawtimber), but they are comparable to rotations used on National forest lands for multiple-use management in the Southeast (60-70 years for loblolly, 80 years for longleaf and pine-hardwoods, and 100 years for bottomland hardwoods). It is recommended that the current rotation lengths be retained for all species in all working groups, except for loblolly pine in the high-intensity pine management working group.

150. The rotation for loblolly pine in the high-intensity pine management working group should be lowered to 40 years. This recommendation is based on an integrated approach to natural resource management consistent with potential site productivity constraints and interactions with other natural

resource values. It is considered that the maximization of timber products at the expense of wildlife values in this working group will be more than compensated for by the implementation of the remainder of the recommendations presented in this report.

151. Prior to making any additional changes in the presently recommended rotation lengths, three factors should be considered. First, the actual diameter growth rates by species should be monitored on the different site classes at Fort Benning in order to develop specific data applicable to the local conditions. Second, the impacts of shortening rotation lengths on the local wildlife habitat conditions should be evaluated. And, third, the impacts of shorter rotations (and consequently more land area being in the 0- to 20-year age classes) on military training needs (i.e., aerial concealment, lines of sight for crew-served weapons, restricted access through young, unthinned stands, etc.) should be explored.

Timber management

152. Management for timber products at Fort Benning should be conducted on a priority basis with the inherent capability of each site class being the primary criterion for the allocation of time and money. This concept of inherent capability includes both potential productivity (as measured by site index) and potential constraints.

153. The management effort should be directed mainly at those sites that will provide the maximum return on the time and capital invested; however, other factors must be considered as well. First, some attention should be focused at all times on the concurrent extensive management of the entire installation (i.e., a certain percentage of the management effort should be invested in less "profitable" sites to maintain continued growth over the entire area). Second, working on certain sites and/or implementing specific practices will be necessary in order to maintain coordination with and facilitate the accomplishment of objectives from other programs. Third, some practices will be required for the restoration of previously degraded sites.

154. The essence of the timber management recommendations is as follows: the high-potential pine sites should be managed intensively for pines (primarily loblolly); the medium-potential pine sites should be managed intensively for pines (primarily loblolly) where the sites will support this, and less intensively for pines (primarily loblolly and longleaf) and/or pine-hardwoods as necessary; and, the bottomland hardwood sites should be managed

to perpetuate bottomland hardwood forest types. More specific recommendations are given for each group below.

Streamside management area working group

155. Definition. The streamside management area working group is equivalent to the streamside management area soil management class. This working group consists of forest stands occupying soils in the ravine, minor bottom, and swamp soil categories. These areas can be identified on the ground by reference to the mapped boundaries of the soil mapping units for the respective soil series.

156. Management type. Essentially any forest type that occurs naturally on these ravine and minor bottom sites is acceptable.

157. Management objective. These areas should function to protect the integrity of the adjacent streams and drainages from soil erosion and water quality degradation. Also, they should serve as "hardwood stringers" to provide travel corridors and feeding/escape cover for wildlife species.

158. Silvicultural system. Normally these areas should not be cut, therefore no silvicultural system is prescribed.

159. Intermediate treatments. None.

160. Cutting interval. None.

161. Regeneration. These areas should be allowed to regenerate naturally.

162. Prescribed burning. All fires, planned and unplanned, should be excluded from these areas.

163. Timber-wildlife coordination. These areas occur throughout the installation in a natural "dendritic" pattern reflecting the distribution of small drainages and streams. They represent a tremendous natural source of interspersion and juxtaposition of natural habitats, and consequently have an inherently high value to wildlife at the compartment and installation (or "regional") levels. The retention of these areas individually and collectively is most important to the wildlife program at Fort Benning.

164. Individually, these areas often represent "hardwood islands in a sea of pines" and thus serve as mini refuges for various wildlife species. As important as this function is, however, the real value of these areas is not realized unless they are effectively linked together. It is therefore both the quality of individual stands and the collective pattern of their occurrence that are important. These values can best be captured by designating

them as special zones where timber-harvesting activities, including "stumping" for naval stores, are excluded.

165. These areas represent the wildlife equivalent of the high-intensity pine management working group. Both of these working groups are dedicated primarily to a single use without any "internal" modifications to accommodate the other use. Coordination between these groups is effected at the landscape pattern scale, as both working groups encompass essentially equivalent total acreages well distributed throughout the installation.

Bottomland hardwoods working group

166. Definition. This working group consists of those stands occupying soils in the major bottoms category.

167. Management type. The major bottoms should be managed to maintain and re-establish the bottomland hardwoods forest types, such as sweetgum-water oaks, red oaks-white oaks-mixed species, beech-oaks, etc.

168. Management objective. These areas should be managed to produce high-value hardwood sawtimber and high-quality wildlife habitat benefits. Mast-producing tree species such as the oaks, hickories, and American beech should be favored in species composition.

169. Silvicultural system. These stands can be managed by group selection (using cuts of 0.5 to 5 acres) and/or shelterwood cuts. The shelterwood system will favor the regeneration of the heavy-seeded species (oaks and hickories) and should be used to ensure their continued dominance (McKnight and Johnson 1975). Putnam, Furnival, and McKnight (1986) and McKnight and Johnson (1975) provide the following guidelines for managing these bottomland stands.

170. Intermediate treatments. First, the species composition and stem quality of the existing stand should be improved by conducting a reconnaissance inventory and prescribing and improvement cut that reduces the number of culls and selects the desired species composition. Next, in shelterwood stands, a series of light thinnings should be applied. These thinnings should continue to favor the desired species and they should open the canopy gradually to minimize epicormic branching. McKnight and Johnson (1975) recommend making the first thinning in even-aged stands when the dominant trees average 8 to 10 in. in diameter at breast height (dbh). A second thinning should be made when the dominants average 14 to 16 in. dbh, and a third thinning should be made when they average 20 to 22 in. dbh. The actual timing

of these cuts will depend on the growth rate of the stand, but the basal area stocking level of the stand should not exceed 110-115 sq ft/acre in order to maintain the best growth of the dominant and co-dominant trees.

171. Cutting interval. A 10-year cutting interval is initially recommended for these stands.

172. Regeneration. The maintenance of oaks as the dominant species in these stands will require that advanced oak regeneration (i.e., seedlings and small saplings) be present prior to removing the overstory. This advanced regeneration can be established and maintained by the shelterwood system whereby the canopy is opened gradually over the life of the stand, with a greater level of release in the cutting cycle immediately prior to the final harvest.

173. Prescribed burning. These stands should be completely protected from fires. Normal prescribed fires will not kill the overstory, but they would probably kill the advanced regeneration and thus possibly adversely impact the future species composition of the stand. Also, basal wounds caused by these fires allow the entry of butt rot organisms into the stems and consequently severely degrade the value of trees.

174. Timber-wildlife coordination. In general, the simple existence of these bottomland hardwood stands will be of tremendous value to the wildlife of the installation. This will be especially true if these stands are interspersed evenly throughout the area, as is the case now with the soils that naturally support these forest types. Therefore, the most important aspect in the management of these stands for wildlife benefits is that they be retained as bottomland hardwoods and not be converted to pine stands.

175. The next-most-important aspect of managing these stands is that they be maintained with high percentages of mast-producing species, especially oaks. A primary value of these forest types is their food-producing potential for a wide range of wildlife species. Maximum species diversity of the oaks should be encouraged, and adequate levels of hickory and beech trees (i.e., 10 to 15 sq ft of basal area per acre in trees $\geq$ 10 in. dbh (Nixon, McClain, and Donohoe 1975) should be incorporated into these stands.

176. The third major item of concern is that of maintaining an adequate supply of natural cavities for wildlife nesting/roosting purposes. A minimum of 10 to 12 cavity trees per acre should be left in the forest to provide a source for these potential nest sites (Teaford 1986a). In addition, certain

tree species prone to natural cavities, such as American beech, should be retained even when their poor form would normally cause management to remove them. A balance must be recognized between "good forestry" and "good wildlife" on this issue; the primary objective is to develop healthy, vigorous timber stands of desirable species composition in order to maximize both timber and wildlife values. It is more important to have well-stocked, vigorous stands of oaks and associated species with an adequate supply of potential cavities than to have an overabundance of cavities in stands of poor form with slow-growing cull trees of less desirable species composition.

High-intensity pine
management working group

177. Definition. This working group consists of stands occupying soils in the terraces and upland, high-potential categories.

178. Management type. Essentially all of the high-potential pine sites should be intensively managed as even-aged loblolly plantations.

179. Management objective. These sites should be dedicated primarily to producing high-quality pine sawtimber with frequent pulpwood thinning design to promote maximum growth on selected residual crop trees.

180. Silvicultural system. Even-aged plantations should be established with approximately 450 trees per acre (8- by 12-foot spacing) to 650 trees per acre (8- by 8-foot spacing).

181. Intermediate treatments. Stands should first be thinned commercially at the ages of 13 and 20 years, and residual basal areas should be maintained at 60-90 ft/acre depending on site quality (60 on poorer sites; 80-90 on better sites). The 8-by 12-foot spacing would allow the first thinning to be a row thinning, starting with the third row and moving to every fifth row thereafter; this would remove every fifth row and thin two rows on either side on each pass through the plantation.

182. Cutting interval. A 10-year cutting interval is initially recommended for the installation. However, the stands in this category may need more frequent treatments due to their expected faster growth. If the stand basal area approaches 120 sq ft/acre or if the live-crown ratios of the trees drops to around 40 percent, then the stand should be thinned in order to maintain vigorous tree growth and lessen the susceptibility to southern pine beetle infestations (Nebeker et al. 1985).

183. Regeneration. Most of these stands can be regenerated by the clear and replant method without any problems. Only when a stand occupies a steep slope should this method pose potential difficulties. However, even on good sites with relatively level slopes, site preparation treatments should be limited to roller-chopping. The use of a shearing blade or a bulldozer to scrape the soil and pile debris in windrows will be most detrimental to the soil. The sandhill soils on which this type normally occurs are naturally low in organic matter, and the little organic matter that is available is concentrated in the shallow surface layers (generally within 2 to 6 in. of the surface). Windrowing essentially "scalps" this layer off of the soil over most of the site and the nutrient availability and internal water-holding benefits normally provided by the organic matter are lost (Swindel et al. 1983, Kellison and Gingrich 1984). Also, when the litter layer is removed, a forest soil loses its inherently high water infiltration capacity and essentially functions as an exposed agricultural soil; the potential hazard for sheet and rill erosion is thereby greatly magnified (Patric 1983).

184. Even though the clear and replant method is relatively "simple," it is by no means inexpensive. For less-expensive alternatives, the shelterwood and seedtree regeneration methods utilizing natural regeneration should be given serious consideration.

185. Prescribed burning. As a standard recommendation, essentially all intensively managed pine stands should be burned for hazard reduction and wildlife habitat benefits on a 3- to 5-year rotation.

186. Timber-wildlife coordination. Any wildlife benefits that will accrue to these intensively managed pine stands will come primarily from the low herbaceous understories that will be promoted by the thinning and burning treatments. As long as the streamside management areas, bottomland hardwood sites, and "scrub" hardwood stands are not converted to pine stands, there is no strong need to alter the "internal" prescriptions for these intensively managed pine stands.

187. However, consideration should be given to the location and size of clear stands, and timber-harvesting schedules should be developed to make the pattern of age classes within compartments and throughout the entire installation more diverse. As a general rule: (a) cut stands less than 10 years apart in age should not be sited adjacent to one another; (b) no more than

25 percent of a compartment should be in the 0- to 10-year age class; and (c) individual stands should be limited to ≤50 acres in total size.

Medium-intensity pine management working group

188. Definition. This working group consists of stands occupying soils in the upland medium potential (clay) and upland medium potential (sand) categories.

189. Management type. The approximately 55,000 acres in this category should be managed for three broad forest type groups. These are: (a) loblolly pine on the better sites in the category; (b) longleaf pine on sites where they now occur and on the drier sites in the category; and (c) other pine types (i.e., shortleaf, slash, Virginia, and mixed pines) wherever they occur naturally.

190. Management objective. The lands in this category should be managed to: (a) maximize quality pine sawtimber production; (b) integrate timber and wildlife management practices to optimize benefits from both programs; and (c) maintain and enhance at least a minimal level of natural diversity among the forest types on the installation to provide for long-term biological stability.

191. Silvicultural system. The opportunity exists on lands in this category to use both even-aged (plantation, shelterwood, and seedtree) and uneven-aged silvicultural systems. In loblolly stands, even-aged shelterwoods are probably most appropriate, supplemented by a modest acreage of plantations. The longleaf stands should be managed as even-aged shelterwoods or possibly as even-aged plantations started from seedlings in containers. The "other" pine types and the pine mixtures can be managed as even-aged or uneven-aged stands, depending on the needs of management.

192. Intermediate treatments. As recommended above, these stands should be subjected to an active thinning regimen in order to maximize growth, stabilize product yield, and protect against insect and disease problems (Nebeker et al. 1985). Also, those stands managed as shelterwoods and seedtree cuts should be thinned prior to the harvest cut (i.e., "preparatory cuts") in order to simulate and establish a seedling crop.

193. Cutting interval. A 10-year cutting interval for both even-aged and uneven-aged stands is recommended.

194. Regeneration. Recommendations for plantations are given above. Although plantations may be necessary to re-establish longleaf on non-stocked cutover sites, the shelterwood system is generally recommended for this species. An overview of the specifics necessary to manage longleaf using the shelterwood system is given by Boyer and Peterson (1983). Reynolds (1959, 1969), Reynolds et al. (1984), and Baker (1985) discuss the techniques, merits, and results of practicing uneven-aged management in pine stands in southern Arkansas.

195. Prescribed burning. Again, as a standard recommendation, essentially all intensively managed pine stands should be burned for hazard reduction and wildlife habitat benefits on a 3- to 5-year rotation. In addition, the longleaf shelterwoods should be burned more frequently initially (every other year) in order to speed the shift to pure longleaf stands with open herbaceous (primarily grass) understories; this will help reduce competition from hardwoods and other pines, and assure the maintenance and regeneration of these stands as longleaf stands.

196. Timber-wildlife coordination. As above, the intensively managed loblolly pine plantations should be earmarked primarily for high-quality sawtimber production; generally, considerations on the relative size and spatial interspersion of these stands by age classes (as given above) are more important than any "internal" modifications to the stands themselves. However, it is important to consider the relative percentages of the installation devoted to the various types of stands by species and silvicultural system in order to maintain overall biological diversity. This can best be accomplished by managing for a number of forest types in a variety of management systems.

Overview of longleaf pine and scrub hardwoods working groups

197. Approximately 57,000 acres of soils at Fort Benning have been designated as the longleaf pine and scrub hardwoods soil management classes based on their potential for supporting longleaf pine/scrub hardwood stands. However, only a small percentage of these soils currently support such stands; many stands are apparently in other forest types--including other pines, pine-hardwoods, and/or upland hardwoods. Because of this situation, four working groups have been allocated to the combination of the soils in the longleaf pine and scrub hardwoods soils management classes.

198. The basic proposal for addressing these four working groups is to selectively retain and manage the best existing stands for each broad forest type category (longleaf pine, pine-hardwood, upland hardwood, and scrub hardwood) in their current respective forest types, while converting the remaining stands to longleaf and scrub hardwood types. The priority of conversion should be given to longleaf on the "better" sites and to the scrub hardwoods on the least productive sites. The conversion process should be active for the longleaf type and passive for the scrub hardwood types. The recommendation to "convert" these sites and to manage such a relatively large percentage of the installation in these forest types is based on the following rationale. First, the Army has a legal obligation to provide for the long-term survival of the Federally endangered red-cockaded woodpecker population at Fort Benning. The best way to do this is to provide an ample supply to quality habitat for the species. Managing large acreages of the installation in the longleaf pine forest type will provide this potential habitat while concurrently supporting an active timber-management program. Second, the principle of matching species to site potential implies that the management effort should be concentrated on those sites most likely to yield the highest returns (e.g., the sites in the high- and medium-intensity pine management working groups) while minimizing investments on those sites most likely to yield low returns (e.g., the scrub hardwood working group). Third, the retention and continued management of significant acreages of pine-hardwood and upland hardwood stands will contribute to the overall biological diversity of the forest at Fort Benning and thus provide important area-wide wildlife habitat benefits at the installation or "regional" scale.

Longleaf pine working group

199. Definition. This working group consists of stands occurring on soils of the upland medium-potential (deep sand) category.

200. Management type. Longleaf pine is the preferred forest type for this working group, and all existing longleaf stands should be retained. Also, potential longleaf sites should be regenerated to the longleaf type at the completion of their respective rotations.

201. Management objective. These sites should be managed to produce high-quality pine sawtimber with an active thinning program designed to promote open stands of well-spaced large-diameter crop trees.

202. Silvicultural system. These stands should be managed primarily as long-rotation, even-aged shelterwoods. In instances of low natural stocking and as needed to assure adequate regeneration when converting from other forest types, longleaf plantations should be established by using container-grown seedlings.

203. Intermediate treatments. Stands should first be thinned at 30 years; additional thinning should be scheduled for ages 40, 50, and 70. The residual basal area goal should be approximately 60 to 70 sq ft/acre. At age 90, a preliminary shelterwood cut should occur, if needed, to reduce the stand basal area to 60 sq ft/acre. A final shelterwood cut (i.e., seed cut) that reduces the residual basal area to 30 sq ft/acre should occur at age 95. The shelterwood overstory should be removed within 2 years after adequate longleaf seedling establishment. Depending on the cycle of seed years in the longleaf trees (3 to 7 years), the overstory removal could be 2 to 9 years after the final shelterwood cut at age 95.

204. Cutting interval. A cutting interval of 10 years is recommended for the first part of the rotation, lengthening to 20 years as the stand ages. The primary guideline is to retain a residual stand basal area in the 60 to 70 sq ft/acre range.

205. Regeneration. Although plantations may be necessary to re-establish longleaf pines on non-stocked cutover sites and on "converted" sites, the shelterwood system is recommended for this species. An overview of the specifics necessary to manage longleaf pines using the shelterwood system is given by Boyer and Peterson (1983).

206. Prescribed burning. It is generally thought that a program of regular and frequent prescribed burning is necessary to maintain and regenerate longleaf stands (Boyer and Peterson 1983). These prescribed burns are normally credited with reducing competition by controlling or preventing the encroachment of hardwood "brush." However, Boyer (1987) has recently raised the possibility that longleaf stands may actually undergo growth declines due to regular and frequent burning. Although final conclusions are pending, the stands studied by Boyer (1987) were on Troup soils in southwestern Alabama and it would be wise for forestry personnel at Fort Benning to establish and maintain contact with these researchers concerning this situation.

207. In the interim, it is recommended that these longleaf stands be burned every other year. When these stands become old enough to regenerate

using the shelterwood system, the prescribed burning schedule should be interrupted long enough to assure the survival of the new longleaf seedlings. These seedlings will be able to survive the stress of a prescribed fire when they have one of the following characteristics: (a) they are roughly 2 years of age or older; (b) they are at least 0.3 in. in root collar diameter during the "grass" stage (Croker 1968, Boyer and Peterson 1983); or (c) they are taller than 3 ft in total height after growing out of the "grass" stage (Fowells 1965). These biennial fires will speed the shift to pure longleaf stands with open herbaceous understories (primarily grasses and legumes). The combination of prescribed burning and thinning will promote the development of open "park-like" stands with high value to various wildlife species. Once these conditions are achieved, a regular burning rotation of 3 to 5 years between fires may be sufficient to sustain them. However, more frequent burns will probably be necessary toward the end of the rotation to assure the transition to the next stand.

208. Timber-wildlife coordination. The longleaf stands in this working group represent the best opportunity at Fort Benning to combine the timber and wildlife programs such that the overall natural resource benefits are optimized. Relatively small reductions in both individual programs from their respective maximums should yield significantly greater benefits from a combined standpoint. These longleaf stands, when managed properly, will provide significant acreages of habitat for the red-cockaded woodpecker as well as game species, and they will yield major harvests of timber products with relatively low risks from fire, insects, and diseases.

209. These longleaf stands should also be actively managed to provide habitat for the eastern wild turkey, bobwhite quail, and various non-game species by incorporating selected habitat improvement practices on a widespread basis throughout the stands in the working group. These practices should include such things as: (a) retaining modest levels of various hardwood tree species scattered throughout the stands to provide wildlife food and cover (Croker 1968); (b) protecting small clumps of thick "brush" and/or small hardwood stems from fires (e.g., "ring-arounds") that serve as escape cover and soft-mast food sources for bobwhite quail (Rocene 1969); (c) discing strips through the woods on the contours to provide a linear interface between last year's unburned dead grasses and open ground for better potential bobwhite quail nesting (Rocene 1969); (d) maintaining strip plantings of bicolor

lespedeza to serve as later-winter food sources for bobwhite quail; (e) maintaining permanent, grassy wildlife openings designed primarily as wild turkey brood habitat; and, (f) retaining small flatwoods "ponds" or vernal pools to serve as breeding sites for amphibians.

Pine-hardwood working group

210. Definition. This working group consists of stands occurring on soils of the upland medium-potential (deep sand) category. As both the longleaf pine and the pine-hardwood working groups occur on soils of the same category, they should be differentiated in the field on the basis of species composition and quality of existing stands.

211. Management type. As discussed above, the goal for this working group is to take advantage of the better existing stands that currently have a mixture of pine and hardwood tree species in the overstory and that occur primarily on soils in the longleaf pine soil management class. Essentially, any forest type that meets the criteria of being a pine-hardwood or a hardwood-pine type is acceptable as a management type.

212. Management objective. The lands in this category should be managed to: (a) maximize quality pine and hardwood sawtimber production; (b) integrate timber and wildlife practices to optimize benefits from both programs; and, (c) maintain and enhance at least a minimal level of diversity among the forest types on the installation to provide for long-term biological stability.

213. Silvicultural system. The opportunity exists on lands in this category to use both even-aged (plantation, shelterwood, and seedtree) and uneven-aged silvicultural systems, depending on the needs of management. In loblolly- and longleaf-dominated stands, even-aged shelterwoods are probably most appropriate. Even-aged plantations started from seedlings (container-grown seedlings in the case of longleaf) may be necessary in order to successfully regenerate the pines in these mixtures, but the mixed pine-hardwood nature of these stands should be perpetuated.

214. Intermediate treatments. As recommended above, these stands should be subjected to an active thinning regimen in order to maximize growth, stabilize product yield, and protect against insect and disease problems (Nebeker et al. 1985). Also, those stands managed as shelterwoods and seedtree cuts should be thinned prior to the harvest cut (i.e., "preparatory cuts") in order to simulate and establish a seedling crop.

215. Cutting interval. A 10-year cutting interval for both even-aged and uneven-aged stands is recommended.

216. Regeneration. Phillips and Abercrombie (1987) discuss an approach to regenerate pine-hardwood mixtures using cutting, spring felling of standing residual hardwoods, summer prescribed burning, and replanting pine seedlings. Reynolds (1959, 1969), Reynolds et al. (1984), and Baker (1985) discuss the techniques, merits, and results of practicing uneven-aged management in pine stands in southern Arkansas.

217. Prescribed burning. Except possibly in the establishment state, pine-hardwood and hardwood-pine stands should not normally be burned.

218. Timber-wildlife coordination. Pine-hardwood/hardwood-pine stands are important in maintaining biological diversity, and three major factors should be considered in selecting the individual stands for inclusion in this working group. First, stands with forest-type mixtures having high percentages of hard mast-producing species should generally be favored for retention. Second, individual stands should be selected to maximize the interspersion of forest types throughout the area, both at the compartment and installation levels. Third, stands should be selected to maximize timber value as measured in terms of adequate stocking of high-value stems.

Scrub oaks working group

219. Definition. This working group consists of stands occurring on soils in the upland low-potential category.

220. Management type. This working group includes those forest types known as the "scrub oaks" and "scrub oaks"-yellow pines. The term scrub oaks implies the following sandhill community types identified by Jones, Van Lear, and Cox (1981): (a) turkey oak/dwarf huckleberry; (b) bluejack oak-sand hickory; and, (c) blackjack oak/deerberry-broomsedge.

221. Management objective. The retention and preservation of these types is the primary objective for this working group. These types were once common in the sandhill region and consequently many native wildlife species are well-adapted to them or dependent upon them for their habitat requirements.

222. Silvicultural system. None.

223. Intermediate treatments. None.

224. Cutting interval. None.

225. Regeneration. These areas should be allowed to regenerate naturally.

226. Prescribed burning. Normally these hardwood stands would not be deliberately included in a standard prescribed burning program. However, as these stands will not have any significant timber resources to degrade and as they will not be cut for timber harvests, the decision to burn should be a local one. This decision should be determined by evaluating the advantages and disadvantages from a wildlife standpoint. The impacts on the local gopher tortoise population should be a good barometer to use in making these decisions.

227. Timber-wildlife coordination. These scrub hardwood stands occur on the very driest sites where the soils are deep (grossarenic) to very deep (quartzipsamments, i.e., sands > 80 in. deep) sands. The potential for quality timber production is marginal at best, and consequently these areas should be allocated as wildlife habitat.

228. All stands currently in these scrub hardwood forest types should be retained as they are, and all loblolly- and slash-pine-dominated stands occurring on the Blanton and Lakeland soil series should be slated for conversion to the scrub oak forest types. All other hardwood forest types occurring on these two soil series should also be retained and allowed to develop naturally. Longleaf pine stands occurring on these soil series should be managed as longleaf stands.

229. The loblolly- and slash-dominated stands should be converted by harvesting the merchantable pines and leaving the hardwoods to develop naturally.

Upland hardwood working group

230. Definition. This working group consists of stands occurring primarily on soils in the upland low-potential category. As both the scrub oak/longleaf pine and the upland hardwood working groups occur on the same soils in the same category, they should be separated on the basis of species composition and the quality of the existing stands.

231. Management type. Any upland hardwood-dominated forest type is acceptable in this working group.

232. Management objective. These areas should be managed to provide high-quality upland hardwood wildlife habitat. Oaks, hickories, beech, and other hard-mast-producing species should be favored.

233. This working group is designed to take advantage of the better existing upland hardwood stands on the soils in the scrub hardwood/longleaf pine soil management class. Although no active timber management is currently recommended, these stands should be considered for timber production at a later date (i.e., after significant progress has been made in regulating the forest stands on the more productive sites).

234. Silvicultural system. None is currently recommended, but at a later data, a system comparable to that used in the bottomland hardwoods working group should be considered.

235. Intermediate treatments. None.

236. Cutting interval. None.

237. Regeneration. Natural succession.

238. Prescribed burning. All fires, planned and unplanned, should be excluded from these areas.

239. Timber-wildlife coordination. The management of these areas should emphasize wildlife benefits. The better existing stands should be retained in their current types and the species composition of the poorer, understocked stands should be converted to the scrub hardwood forest types.

240. Initial timber management, when implemented, should focus on the stocking of hard-mast-producing species, especially the oaks.

Wildlife

241. The basic philosophy recommended for the accomplishment of wildlife management goals and objectives at Fort Benning is to maximize the benefits to be gained through close coordination with the active timber management program conducted on the installation. Fort Benning is primarily a forested landscape and most of the changes in the wildlife habitats will be made as a result of harvesting timber. It is therefore important that wildlife habitat considerations be fully incorporated into the timber management program, and that wildlife habitat objectives and constraints be given equal weight with timber objectives in order to achieve a truly integrated multiple-use natural resources management program.

242. A certain level of "direct" management activities (i.e., other than timber-wildlife coordination) will be needed as well. These activities should be used to enhance the benefits gained from inter-disciplinary

coordination, and to provide essential habitat features, population information, and wildlife needs not provided as a result of the timber program.

Goals and objectives

243. The primary goal of the wildlife program at Fort Benning is essentially the same as the forestry goal: to provide an optimum mix of natural and managed habitats capable of producing wildlife and other multiple-use benefits on a sustained basis in a manner that protects and enhances the long-term stability and productivity of the soil resources of the installation.

244. It should be noted that the timber and wildlife programs are essentially two ways of looking at the same problem, that of optimizing the mutual benefits derived from the same resources. Optimization is the key concept; a mix of benefits should be maximized instead of concentrating on any one single component.

Management approach

245. The objectives of and approach to wildlife management are similar to those given earlier for forestry. The approach consists of determining current conditions, setting long- and mid-term goals and objectives, designing and implementing annual management plans, and monitoring progress. Specific program-level objectives are:

a. Determine target species for management emphasis.

b. Set management objectives for each target species population.

c. Determine a management scheme for each target species. This scheme should be based on species biology, current habitat conditions, and required future conditions needed to sustain the population at desired levels.

d. Implement an active program of habitat manipulation and population management tailored to the specific needs of each species.

e. Monitor program success and modify as required.

246. Target species and population objectives. Six species were identified by Fort Benning as target species for management. These were: white-tailed deer, eastern wild turkey, bobwhite quail, eastern gray squirrel, red-cockaded woodpecker, and wood duck. The status and population objectives recommended for each species are:

Species	Status	Population Objective
White-tailed deer	Resident game	1 per 25-30 acres
Wild turkey	Resident game	1 per 20-64 acres
Bobwhite quail	Resident game	1 per 5-10 acres
Gray squirrel	Resident game	1 per 2 acres
Red-cockaded woodpecker	Resident endangered species (Federal)	120-400 active woodpecker colonies
Wood duck	Nesting migratory waterfowl	5-10 managed beaver pond complexes

247. Management scheme. It is impractical to manage for everything on every acre, so some priorities must be established. These priorities should be based initially on the requirements and adaptability of each species. Some species are flexible in their habitat needs and can adapt to a wide range of conditions. For other species, habitat requirements are strict and the individuals do not respond well to suboptimum circumstances.

248. The wildlife program at Fort Benning can address this issue of differential species flexibility by accommodating the stricter needs of the least flexible species first, and then providing for the more flexible species later. One way of doing this would be to designate special management zones dedicated to fulfilling the needs of the inflexible species, while managing for the more flexible species on a more extensive basis.

249. The concept of management zones should not be limited to simply protecting inflexible species (e.g., the red-cockaded woodpecker); zones for other species should be considered as well. These zones are potentially valuable in at least two additional ways. First, they provide a positive means to insure that critical habitat components are included within the range of selected species populations by incorporating the geographical aspect of habitat in the management planning, evaluation, and monitoring process. Second, they help focus and concentrate initial management effort on discrete land areas and increase the overall probability of success.

250. The process of designating management zones allows one to optimize the habitat conditions for a given species or species group on discrete, manageable areas. This does not mean, however, that the management of a given species will only taken place in these zones. Each species selected for management emphasis should be considered over the entire installation. By concentrating efforts in these smaller management zones, the probability of

initial success is greater; as these successes build, increasingly greater levels of effort can then be logically directed to other areas.

251. While management for the habitat needs of a given wildlife species may be the "primary" consideration within one of these zones, other species will normally be considered as well. Also, individual species will normally be accorded less emphasis outside of their respective zones. For example, the habitat needs of the eastern wild turkey should be the driving force within a turkey management zone, while outside of that zone, the intensive management of loblolly pine plantations should be given priority on those sites best suited to intensive pine culture.

252. The recommended size and number of management zones will vary by species. Each zone should be large enough to support a population of a particular species; thus, the sizes of these zones will depend on the needs of each individual species. As to the number of zones for each species, it seems more logical to start with a smaller number of geographically spaced zones that will be managed intensively than to initially have a larger number that cannot be managed as well. The levels of effort required and resources available are important considerations.

253. Primary and secondary zones should be identified and designated to provide management flexibility in this part of the program. Primary zones would be those designated for immediate intensive management, while secondary zones would be slated for extensive management initially. As the program progresses, these secondary zones should be phased into a routine of more intensive management on a predetermined schedule of priorities. This approach would allow room for expansion of the total number of zones allocated for each species, and provide flexibility for the level of management efforts applied to individual zones.

254. Habitat manipulation and population management. As mentioned above, most of the wildlife management on the installation will be a directed result of the timber-harvesting program. Whether this circumstance impacts the target wildlife species beneficially or adversely will depend on coordination between the programs. The wildlife biologist should certainly take the lead in this effort, but success will not be possible without close cooperation from the forester and the full support of the installation natural resource manager.

255. First-class management of the forest ultimately benefits both the wildlife and timber management programs. Currently, the wildlife program has no way of generating specific revenues of any consequence, so wildlife must rely on the timber program and its revenues. At the same time, the timber management program depends on the wildlife program for management flexibility in dealing with endangered species and for widespread public support. Given this interdependence, the job of the wildlife staff is to coordinate these programs and to help guide them away from damaging practices and policies and in those areas that are mutually beneficial to both programs and ultimately to the American public.

256. This coordination with and modification of the timber program should be supplemented with appropriate "direct" habitat and/or population manipulations. These additional activities will be necessary in order to supply critical habitat components and/or to remove limiting constraints for the various species populations. Also, population regulation will be required, in some instances, to maintain healthy populations that are in balance with their habitats.

257. Program monitoring. This aspect of the wildlife program will be needed in order to evaluate the overall success of management. It should be designed and used to follow the results of individual practices as well as success rates in specific management zones. Decisions as to what levels of effort should be maintained and when management efforts should be shifted to new areas depend on this information.

258. This information is somewhat analogous to site productivity, growth, and yield data in forest management. A balanced program of habitat and population monitoring should be used. Habitat monitoring should indicate the potential quality of the habitat, and the population data should indicate the general trends of species responses.

Specific wildlife management recommendations

259. Given the list of selected target species, and with the GIS methodology and data generated by this study, the wildlife staff at Fort Benning should find those places most suitable for each particular species, both now and in the future. This should be done in coordination with the other aspects of the program (i.e., timber) in order to mutually agree on specific management areas. Having completed this process of designating management zones for

each species or group of species, specific mid- and long-term plans for each area should be developed. With these plans in hand, they can be implemented through "indirect" coordination with and modification of the timber program, and with "direct" habitat and/or population manipulations.

260. General guidelines for each target species are given below, but more specific guidance is available in the technical literature. Much of what is presented here comes from information provided in the USFS Southern Region Wildlife Habitat Management Handbook (USFS 1971).

Red-cockaded woodpecker

261. Management objective. With an approximate total of 120,000 acres available for forest management in the pine and pine-hardwood forest types, Fort Benning's objective for active red-cockaded woodpecker (RCW) colonies falls between 120 and 400 colonies. These colony requirements were derived from the "Policy and Management Guidelines for Red-Cockaded Woodpeckers on Army Installations"* as agreed to by the Office, Chief of Engineers (OCE) and FWS. These guidelines set a minimum requirement of one colony per 1,000 acres and a maximum requirement of one colony per 200 to 400 acres.

262. According to Lennartz et al. (1983), Fort Benning has approximately 65 to 70 active red-cockaded woodpecker colonies. As this number falls below the one colony per 1,000 acres minimum, the OCE/FWS guidelines specify that Fort Benning should be managing its forest lands to promote red-cockaded woodpecker colony recruitment up to at least this minimum level.

263. Management approach. RCW management at Fort Benning involves retention of existing colonies, recruitment of new colonies, and provision of acceptable foraging habitat adjacent to existing and potential colony sites. Basic guidance for accomplishing these three tasks is provided in Section B of the OCE-FWS guidelines.

264. Timber-wildlife coordination. In the management recommendations presented in the forestry section above, three items are important for achieving the required RCW population. These are: (a) the provision of the approximately 9,000 acres of "permanent" old-growth timber stands; (b) the designation of a longleaf pine working group managed on a 100-year rotation;

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* Policy letter/directive, 25 Oct 1984, E. T. Watling, Chief, Facilities Engineering Division, Office, Assistant Chief of Engineers, OCE, Washington, DC.

and, (c) the designation of a medium-intensity pine management working group and a pine-hardwood management working group managed on 80-year rotations.

265. The roughly 9,000 acres designated to be managed as old growth will potentially provide for approximately 225 RCW colony sites consisting of individual 40-acre stands. Currently, this required old growth acreage, which would be potentially acceptable as RCW colony site habitat, does not exist. For this reason, the preservation of pine and pine-hardwood old growth stands should assume a high priority. A preliminary time schedule for achieving this old-growth objective is presented in Table 15.

266. The designation and management of a longleaf pine working group on a 100-year rotation should help provide potential cavity trees and good foraging habitat. It is recommended that the individual stands in this working group be managed using the even-aged shelterwood silvicultural system. These stands should be thinned and burned frequently on a prescribed basis to provide the open "park-like" habitat conditions needed by the RCW. The older stands in this working group should be the primary source for recruitment stands for additional colony sites in the future.

267. Medium-intensity pine management and pine-hardwood working groups should provide significant amounts of potential RCW foraging habitat. These stands should also provide occasional cavity trees and thus potential colony sites. However, the potential for new colony sites will probably be less in these working groups than it will be in the longleaf pine working group.

268. The relatively long rotation lengths and the intensive management of these pine acreages (i.e., frequent thinning and prescribed burning) should provide the acreage needed to serve as a foundation for the RCW program. This acreage base of potential habitat, when coupled with other specific guidance, should help to optimize high-quality RCW habitat throughout the installation on a sustained basis.

269. For ease of management and to insure that the RCW population is adequately provided for as required by Federal law, it is recommended that each individual colony site plus an appropriate buffer be designated and managed as an individual RCW management zone. This concept is mandated by the OCE-FWS guidelines, which provide general information on the subject. More specific information detailing the silvicultural approaches and objectives needed to manage these RCW zones (i.e., the 1,200-m zones around RCW colony

sites) is presented in the comprehensive plan for RCW management on the National Forests of Texas (USFS 1988).

270. Direct habitat improvements. Direct practices for improving RCW habitat generally consist of protecting individual cavity trees from burning during prescribed fires, and in controlling understory/midstory hardwoods within the colony site. These items are discussed in the OCE/FWS guidelines and in USFS (1988) along with recommendations on marking and monitoring colony sites, and the use of cavity "restrictors" (metal plates placed over a cavity to keep out cavity nesters that use entrance holes greater than 1.5-in. in diameter).

Eastern wild turkey

271. Management objective. Desired fall populations of wild turkeys range from 10 to 32 birds per square mile (1 turkey/64 acres to 1 turkey/20 acres), and minimum size of wild turkey management zones should be 5,000-6,000 acres (USFS 1971). The recommended objectives for Fort Benning are four to six primary management zones with population goals of 32 turkeys per square mile, four to six secondary zones with initial population goals of 20 turkeys per square mile, with the remainder of the installation having at least an average population of 5 to 10 turkeys per square mile. After the primary zones reach their population objectives, the secondary zones should also be managed to achieve population levels of 32 turkeys per square mile.

272. Management approach. Wild turkeys should be managed in zones with a projected goal of 10 zones being actively managed. Zones should be sited to maximize opportunities for turkey management, while concurrently minimizing conflicts with timber management on lands within the high-intensity pine management working group. These zones should be interspersed throughout the installation in order to equalize the geographic distribution of the wild turkey population at Fort Benning.

273. Timber-wildlife coordination. These wild turkey management zones should be based around core areas of hardwood forest types, supplemented with extensive acreages of managed pine stands. In general, at least 20 percent of a zone should be composed of some well-distributed combination of streamside management areas, bottomland hardwoods, and/or scrub hardwoods (for hard-mast production), and no more than 33 percent of the zone should be in the 0- to 20-year age classes.

274. The scrub hardwood forest types are particularly important as food sources for wild turkeys. These forest types produce significant supplies of acorns on upland sites, starting at relatively young ages. This combination of upland and lowland stands of hardwood forest helps assure an adequate supply of hard mast.

275. The proposed management of the respective pine and pine-hardwood working groups should be beneficial to the wild turkey population as long as the stands in the younger age classes (0 to 30 years) are well-distributed spatially on the ground. These young pine stands should be desirable as nesting and feeding areas for the first 3 to 5 years after establishment. However, from the time of initial crown closure until they are opened again in the thinning and burning schedules, these stands will be of little value to turkeys. Once the thinning and burning programs begin, these pine stands should then be desirable for turkeys throughout the remainder of the rotation.

276. Direct habitat improvements. Although timber-wildlife coordination will provide the bulk of the habitat needs for wild turkey management, direct habitat improvement projects may be necessary as well. The two primary projects considered should be permanent grassy clearings for brood habitat, and wildlife food plots for supplemental food sources. An average of four permanent grassy openings per square mile, ranging from 1 to 5 acres in size, should be developed on all turkey management zones. Also, one to two small food plots of chufa (*Cyperus esculentus*) per square mile may be desirable. Often, these grassy openings and food plots can be sited to take advantage of utility rights-of-way, log decks, skid trails resulting from thinning, or other management-induced openings.

Bobwhite quail

277. Management objective. Five primary and five secondary quail management zones, each approximately 3,000 acres in size, should be set up initially. The primary zones should be managed to achieve a quail population of one quail per 5 acres. The secondary zones should be initially managed for a population of one quail per 10 acres; this objective should increase to one bird per 5 acres as soon as the primary zones are meeting their objectives.

278. Management approach. Bobwhite quail management at Fort Benning will have to rely primarily on intensive forest management modified somewhat to provide high-quality quail habitat. Managed farm habitats are not available, nor practical on the installation. Supplemental food requirements

needed to increase the local populations will have to be provided by a food plot program.

279. Timber-wildlife coordination. The working groups and silvicultural systems recommended for the forestry program should assure reasonable habitat potential over the majority of the installation, but the primary and secondary management zones will be the heart of the quail management at Fort Benning. These quail zones should be placed in areas having a high percentage of sites on soils in the upland high-potential, upland medium-potential (clay), and terrace soil categories. These soils generally have medium soils moisture availability ratings and have the potential to produce fair to good grain and seed crops (especially corn and soybeans). These soil characteristics are apparently more desirable as a basis for quail production than are drier or wetter soils (Landers and Mueller 1986).

280. According to Landers and Mueller (1986), dry upland sandy soils (e.g., scrub hardwood and longleaf pine sites) "generally support few native seed plants or insects of the types eaten by quail." On the wet sites such as streamside management areas and bottomland hardwoods, these authors state that "Quail numbers fluctuate most in wet-site areas." They attribute this to: a scarcity of quail food plants on these sites (especially wild legumes); the tendency for these "flatwoods" soils to be deficient in key nutrients (e.g., nitrogen and phosphorus); and the flooding of nests and the mortality of young chicks due to prolonged dampness as a result of heavy summer rains. It appears that the high-quality upland soils, the medium-quality upland clayey soils, and the terrace soils, respectively, are the most desirable sites for intensive quail management efforts at Fort Benning.

281. Intensive timber thinning and prescribed burning are essential to good quail management at Fort Benning. The primary food sources for quail on the installation will be native plant seeds, especially wild legumes, supplemented by pine mast and hard mast. These native herbaceous foods will not be available in adequate levels if the forest stands are not maintained in a fairly open condition.

282. In pine and pine-hardwood stands, the residual basal area levels should be maintained at approximately 60 sq ft per acre on less-productive sites. On better sites, the basal area should be maintained at a level equivalent to the site index minus 30 percent. The application of this guide will result in individual forest stands approaching a crown closure value of

approximately 40 percent. This means that the overstory will be "open enough for direct sunlight to make large patches on at least 60 percent of the area at one time" (Rocene 1969).

283. On each quail management area, a program of annual winter prescribed burning should be practiced over most of the area (Landers 1987). Frequent use of controlled fires helps to promote the growth and seed production of desirable food plants, which is a critical aspect of good winter habitat. These planned fires also tend to improve summer habitat conditions for quail by reducing ground litter, thinning "rough" stands of understory and ground cover vegetation, and by attracting insects to the re-sprouting vegetation where they can be eaten by adults and broods (Rocene 1969, Landers and Mueller 1986). If possible, these fires should be conducted between the end of the hunting season and the beginning of the nesting season. Individual burns will be more valuable to quail if they are "spotty" and do not burn evenly over the entire area. This uneven coverage tends to promote a desirable pattern of vegetative diversity. Specific details on recommended burning techniques are available in Rocene (1969) and Landers and Mueller (1986).

284. Direct habitat improvements. In order for the quail management program to be successful, it will be necessary to supplement the silvicultural recommendations with a number of these "direct" improvement practices. Activities needed include: discing, chopping, and mowing for vegetation manipulation; planting, fertilizing, and/or liming food plots for alternate food sources; and, providing escape cover by protecting selected thickets (Rocene 1969, and Landers and Mueller 1986).

Eastern gray squirrel

285. Management objective. A fall population of approximately one squirrel per 2 acres should be adequate to provide good hunting.

286. Management approach. Gray squirrels should be managed at Fort Benning by providing suitable habitat. This should be accomplished by retaining the hardwood stands in the streamside management area, bottomland hardwood, upland hardwood, and the scrub hardwood working groups. Active management within these stands should consist primarily of improving tree species composition to retain and release those species most desirable as hard- and soft-mast producers, and as sources of potential cavities.

287. Timber-wildlife coordination. The best timber management for gray squirrels is to promote the development of old, mature stands of hardwoods.

This can done by simply letting the existing stands in the hardwood-dominated working groups develop naturally. However, if a more active approach to managing the gray squirrel is desired, the reader is referred to the guidelines provided in USFS (1971) and Teaford (1986a).

288. Direct habitat improvements. The only significant direct habitat improvement practice generally implemented for the gray squirrel is to provide a supply of artificial nesting structures. Detailed techniques and guidelines for doing this are presented in Teaford (1986b).

Wood duck

289. Management objective. It is difficult to specify a population objective for wood ducks at Fort Benning. Instead, management should concentrate on providing an acceptable number of beaver pond complexes to serve as centers of high-quality breeding, brood rearing, and migratory/wintering habitat. Initially, 5 to 10 of these complexes should be targeted for implementation to serve as prototypes. As positive experience is accumulated on these areas, additional complexes can be started. Also, two or four small subimpoundments or greentree reservoirs should be evaluated for possible implementation.

290. Management approach. Management for wood ducks at Fort Benning should consider: (a) providing proper brood habitat for nesting birds; (b) providing sufficient numbers of natural cavities and artificial nesting structures for nesting birds; and, (c) providing adequate feeding, loafing, and roosting habitat for migrating and wintering birds. Primary emphasis should be on providing proper brood habitat.

291. In order to provide this brood habitat, a number of natural beaver pond complexes should be encouraged and managed. Individual complexes should consist of three to four beaver ponds interconnected by streams so that hens and their broods can move freely between these ponds. As individual beaver ponds get older, they tend to become more desirable as brood-rearing habitat due to the development of stands of rooted emergent and floating vegetation that serve as sources of food and cover for young ducklings. These complexes should be organized around these older beaver ponds, with a certain number of newer beaver ponds allowed to develop around them. The number of "newer" ponds allowed to develop should be monitored to balance the tradeoff between the amount of wood duck habitat created and an acceptable level of damage to existing timber stands. This acceptable tradeoff level should be determined

locally by considering the uses of the impacted resources on a case-by-case basis.

292. The second aspect of managing for wood ducks is that of nesting cavities. Natural cavities can be encouraged by retaining tree species that are likely to develop these cavities. A list of these species is found in Teaford (1986a) (i.e., the same species to favor for tree cavities for gray squirrels). Guidelines on constructing and placing artificial nesting structures for wood ducks are found in Ridlehuber and Teaford (1986).

293. The task of providing feeding, loafing, and roosting habitat for migrating and wintering wood ducks, as well as other species, focuses on the management of these beaver pond complexes and bottomland hardwood stands. The beaver ponds will naturally be used as loafing and roosting sites, especially those ponds with thick stands of buttonbush, *Cephalanthus occidentalis*. Feeding in the beaver ponds can be encouraged by annually draining and planting some ponds to Japanese millet (*Echinochloa crusgalli*) in late summer each year after the wood duck broods have fledged and no longer depend on them for brood habitat. Feeding in the bottomland hardwood stands will depend on natural overflow conditions that flood these forests, unless some program of developing small sub-impoundments in these areas is initiated. Guidelines for beaver pond management are provided in Teaford (1986c), while guidelines for greentree reservoir management are provided in Mitchell and Newling (1986).

294. Timber-wildlife coordination. Primary coordination between timber and wildlife resources involves the bottomland hardwood stands. As mentioned above, it is recommended that some new beaver ponds be encouraged to develop in conjunction with pre-existing older ponds in order to provide manageable units for wood duck brood habitat. The location and extent of these complexes should be determined prior to their development, and they should be sited to maximize their detrimental impacts on any potentially valuable timber resources. These beaver pond complexes should be monitored to limit their growth to an acceptable level; unacceptable growth will probably have to be controlled by site-specific beaver trapping programs.

295. Coordination will also be necessary regarding the potential construction and operation of any sub-impoundments in the bottomland hardwoods for waterfowl management.

White-tailed deer

296. Management objective. A population level of one deer per 25 to 30 acres should be acceptable at Fort Benning to produce a sustained number of quality white-tailed deer (WTD) for annual harvest without interfering with military training or forest management.

297. Management approach. As long as the forest resources are managed as recommended in this report, the needs of the WTD herd at Fort Benning should be adequately met by the food and cover resources made available. Deer management efforts should be conducted in conjunction with state game officials and should concentrate on population estimation and management through hunting and analysis of harvest data. Direct habitat manipulation should be practiced only as needed to produce higher quality animals or to help concentrate deer for harvest.

298. Estimates of WTD density can be obtained by conducting spotlight and track counts on selected areas of the installation. Spotlight counts should be conducted annually in late August or September on predetermined, permanently established transects. Track counts should also be conducted annually, in late winter to establish baseline data to observe long-term trends and short-term fluctuations in population density. Additional information on spotlight and track-count methodologies can be obtained from Mitchell (1986a, 1986b). Browse surveys done annually in late winter on permanently established transects should provide estimates of deer density and stocking and overall range conditions. Lay (1967) discussed these browse survey procedures in detail for the southeastern United States.

299. Analysis of harvest data will also provide significant insight into the dynamics of the WTD herd at Fort Benning. These data should be examined for the following relationships:

a. Live/dressed weights.
b. Antler development.
c. Percent lactation.
d. Age class distribution.
e. Buck/doe ratios.
f. Indices of reproductive potential.
g. Abomasal parasite counts.
h. Kidney fat index.

Annual statistical comparisons of these data should be used to monitor the result of management strategies currently in place, and to detect significant changes in herd conditions.

300. Timber-wildlife coordination. The primary coordination measure should be the retention and protection of the upland/scrub hardwoods and the streamside management areas/bottomland hardwoods. These areas provide critical food and cover resources for WTD, and they should be retained as recommended in the forestry section above. Permanent firebreaks and markers should be constructed and maintained around major hardwood stands and drainageways in order to prevent their destruction by wildfire and military training.

301. Prescribed burning for forest management purposes should be coordinated with the wildlife management section to insure that all areas burned are maintained on the appropriate prescription schedule. Prescribed burning not only reduces the competition for pine production, but also can increase the nutrient content of woody browse species utilized by WTD (Shrauder and Miller 1969).

302. Clearcuts should be limited to 40 to 60 acres and should be configured to create the maximum edge effect. Large and contiguous clearcuts should be avoided. Shelterwood and seed-tree cuts should be used as regeneration methods whenever feasible.

303. Direct habitat improvements. Supplemental plantings may be needed to provide high-quality, nutritious forage to augment native foods during critical seasons (e.g., late summer and winter). These plantings should be developed as food plots, 2 to 5 acres in size, and as food strips along log roads, tank trails, and permanent firebreaks. Also, clearcut areas not scheduled for immediate reforestation should be planted as well.

304. The total number of acres to be planted should be determined on the basis of the population size, and on harvest and condition data collected on the installation. These areas should generally be planted with cool-season grasses and fertilized appropriately; specific recommendations as to species to plant, planting data, and fertilization needs should be developed locally in conjunction with the SCS and state game biologists.

Military Training

305. In order to establish military training requirements for use in developing the prototype land-allocation process, training officers and/or training non-commissioned officers (NCO's) in all major units and training activities were interviewed. Also, past training records from the Department of Plans and Training (DPT) were examined to determine training area usage by activity and time. In almost all cases, it appears that maneuver training areas were selected more on the basis of familiarity with the area than on specific environmental factors. Attempts to establish a need for particular environmental parameters such as open woods for longer sight distance, or mature woods for protection from aerial surveillance, were unsuccessful. The ability for trainers to articulate specific environmental needs could enhance both their training mission by allowing them to train troops under specific conditions and the mission of land management personnel to maintain lands in proper condition. It is recommended that environmental training requirements be reviewed and guidelines established to aid trainers and land managers in assigning training areas to meet these needs.

306. The application of military training requirements in this study was based on the actual use of the training areas from historic training records. Assumptions and caveats about the training were made on the basis of experience and were intended to show the feasibility of using such a method. These are explained in greater detail in the GIS procedures in Appendix B.

Alternative Land Uses

307. Numerous potential activities were reviewed for possible use at Fort Benning in order to generate increased revenue. This was a major concern of the US General Accounting Office (1981) and provided at least part of the impetus for this study. Of all the activities reviewed, only two were seriously considered to have any potential - recreation and agricultural activities.

Recreation

308. Opportunities for recreation at Fort Benning can be divided into two categories: general outdoor recreation, such as picnicking, camping, boating, etc., and hunting and fishing activities.

309. Outdoor recreation activities. The major outdoor recreation facility at Fort Benning is Uchee Creek Recreation Area, located in Alabama. Facilities include 34 campsites with water and electrical hookups, a primitive camp area, a bait shop, and a central building with a capacity for 150 people (for unit functions). The area also has a fishing pier, boat ramp, and a marina where canoes, boats, and motors are available for rent. Activity at Uchee Creek has declined over the past few years.

310. Plans for the development of an area at King's Pond (75 acres) were established in 1985. This would include the installation of latrines and a portable bait shop to respond to high visitation rates.

311. Additional recreation opportunities are provided by the installation through the rental of boats and canoes. The demand for canoe rentals has increased over the last few years.

312. As of 1984, there was no master plan for outdoor recreation, either existing or proposed. Development of areas is based on observation of need rather than an understanding of visitation patterns or the expressed interests of recreationists.

313. Three recommendations can be made to address the outdoor recreation issues. First, an assessment of visitor needs should be periodically conducted through the use of interviews or questionnaires. This could be accomplished through cooperative agreements with the recreation departments of state, local, or Federal agencies. Such assessments could be used to insure quality recreation.

314. Second, an outdoor recreation master plan should be formulated, based on the above assessment. This would allow those installation personnel charged with the responsibility for providing outdoor recreation to more effectively plan for and utilize resources.

315. Third, the potential for establishing an off-road vehicle area at Fort Benning should be explored. There are very few motorcycle trails in the lower Chattahoochee Valley and a need for such trails does exist. This could provide an alternative outdoor activity and increased revenue. Designated areas also tend to protect the installation as a whole by confining such activities.

316. Hunting. Currently, hunting privileges at Fort Benning are limited to installation personnel because of a perception that it is dangerous to allow the general public access due to the heavy use of explosives rounds.

However, a survey of other TRADOC installations, including both Fort Sill, Oklahoma and Fort Bliss, Texas, indicates that they both allow the general public to hunt. Both of these installations experience as much, if not more, training involving explosives. Most of these other installations receive at least 50 percent of their hunting pressure from the public.

317. All of the installations provided some type of priority system for installation personnel over the general public. This ranged from allowing the public to apply for permits only after all installation personnel were accommodated, to varying fees, to allowing the general public to hunt only as guests of installation personnel.

318. None of the installations experienced undue difficulties with the general public. In most cases, the general public was very cooperative with installation personnel, especially when wildlife research activities were being conducted.

319. Results of a Georgia deer club survey (1983-1984) show that deer hunters pay an average of $132 annually per person to hunt on privately owned or leased land in the counties surrounding Fort Benning (Johnson 1984). This represents a potential revenue source that could be used for increased wildlife management activities. Permit records for Fort Benning for 1986 through 1987 show that 265,007 permits were available for deer hunting. However, only 28,619 (10.8 percent) were issued. This represents not only a loss of potential revenue, but also the waste of a valuable management tool for producing and maintaining a quality deer herd.

320. It is recommended that hunting and fishing at Fort Benning be opened to the general public. However, first priority should be given to military and civilian employees. The fee schedule that has been proposed is $25 per year.

Agricultural/outleases

321. The second major area of concern for potential revenue-generating land use was agricultural activities. These activities include both crop production and the leasing of installation lands for grazing or hay production. Based on current information obtained from local agricultural extension specialists, there appears to be no potential demand for either of these activities at Fort Benning. The agriculture industry in Chattahoochee and Muscogee Counties is almost nonexistent, with no row-crop production and very few cattle raisers (on a commercial scale). Should demands for hay or grazing

leases develop in the future, they should be accommodated as much as possible. Procedures in use at other installations should be examined and adapted.

PART IV: ORGANIZATIONAL RECOMMENDATIONS

Introduction

Present responsibilities

322. Based on interviews with key personnel within the chain of command at Fort Benning, the current structure and organization appears to be inadequate for integrated land-use planning and management. There are three main areas of concern. First, too few fully qualified personnel are available, especially when considering the need for integrated natural resource management. Second, functional authority and responsibility for some key activities is often split between two different offices. For example, the Environmental Management Office (EMO) has responsibility for endangered species and archaeological/historical sites. However, the daily management of the resources and activities that most often affect these areas rests within the Natural Resources Management Office (NRMO). Third, responsibility for monitoring soil erosion is found in the EMO. However, the problem is often caused by either training or timber harvesting, and restoration must be implemented by NRMO. On most military installations, soil erosion is one of the most serious problems and should be addressed at a high priority level (Jahn, Cook, and Hughes 1984), as both military training and the Natural Resource Management Program depend on effective conservation of these soils. Soils are finite resources and are essentially nonrenewable in the contemporary/historical time frame. Up to a certain point, damaged and degraded soils can be restored economically; past this point they may have to be retired and replaced with additional acreage.

323. Because the restoration of soil resources and the purchase of additional acreage are both so expensive, soil degradation should be held to an absolute minimum. This can best be accomplished by a program of prevention or minimization of damages (i.e., conservation) coupled with prompt repairs where such damages are unavoidable. To be successful, this should be a high-priority program that reports directly to the Installation Commander to ensure command emphasis and compliance.

324. Changes in the current organizational structure and responsibilities are needed in order to realize the full benefits of integrated planning

and management. These changes are not specific to Fort Benning; they can and should be reviewed for application at other installations.

Recommendations

Land-Use Planning Overview Office

325. A Land-Use Planning Overview Office (LPOO) should be formed and should be directly responsible to the Installation Commander. Specific responsibilities should include: soil conservation (Soil Conservation Section), installation GIS (GIS Section), and coordination of environmental impact assessment (EIA) activities. Both the soil conservation and the EIA functions are transferred from the EMO. The LPOO would serve as the central focal point for integrated land management and planning. Decisions that serve the overall interests of the installation, rather than the proprietary interests of individual activities (training, forestry, wildlife, etc.) would be arbitrated within this office.

326. Soil Conservation Section. The goal of the Soil Conservation Section should be to: (a) minimize new erosion sources through preventative coordination of planned activities; (b) respond quickly to repairing current damages; and (c) eliminate older sources of erosion through the restoration of these pre-existing problem areas. In order to accomplish this goal, the soil conservation section of the LPOO should perform these three basic functions:

a. Prevention of damages.

b. Quick-response damage control.

c. Long-term restoration.

327. Military trainers and natural resource management personnel should be required to coordinate with this section prior to implementing their activities in order to prevent or minimize adverse impacts to the installation's soil resources. Soil conservationists should: (a) develop site prescriptions to minimize soil erosion and compaction problems on a case-by-case basis; (b) develop general guidance for usage of all areas of the installation, with special emphasis on the use of critical, highly erodible soils; (c) conduct site visits to provide assistance and to monitor compliance; and (d) develop and implement educational/training programs promoting soil conservation in the military training environment.

328. Recommendations for the implementation of best management practices (BMP's) designed to comply with the Section 208 requirements of the Federal Clean Water Act to control and prevent non-point source population from silvicultural activities is an excellent source of guidance for this function. Specific program recommendations on which BMP's to use, and compliance survey forms are available from the Georgia Forestry Commission and the Florida Division of Forestry.

329. The quick-response damage control function of this section should be provided by a task force equipped and manned to conduct on-the-ground immediate action restoration as recommended by Jahn, Cook, and Hughes (1984). This task force should routinely repair damages caused by military training exercises; each training exercise and/or activity should budget sufficient funds to pay for this restoration work.

330. This same task force, supplemented as needed by contractors, should also conduct the long-term soil restoration function. These efforts should be directed at the restoration of degraded/eroded lands that resulted from the accumulated impacts of previous military training and/or natural resource management activities. Funding for these projects will have to be included in the overall installation budgeting process on a priority basis.

331. This section should be staffed with personnel fully qualified in soil science (particularly forest soils), soil conservation, and soil/plant community restoration techniques. These individuals should be able to plan and implement the specifics of this program.

332. It is recommended that this section be placed in the Land-Use Planning Overview Office because the critical nature of the work to be accomplished requires an independent authority stemming directly from the Installation Commander. However, it is also recommended that this section, as a part of the Land-Use Planning Overview Office, be physically located with the NRMO. The advantages of locating these two offices in the same area would be: (a) to foster day-to-day coordination with natural resource management personnel in planning and conducting their silvicultural and biological programs; and, (b) to simplify natural resource coordination efforts between military trainers and natural resource management disciplines.

333. GIS Section. GIS should be viewed ultimately as an installation management tool. It can serve not only to provide up-to-date inventory information, but can also be used to provide rapid assessment of alternatives

for all activities and their interactions and to provide quick and accurate assessments for EIA's. The Department of the Army's (DA) current dedication to installing geographic information systems at the installations, and the ongoing Integrated Training Area Managed System study, underscore the need for formal recognition of this function.

334. Therefore, a GIS Section should be included in the Land-Use Planning Overview Office. This section would provide ongoing GIS support to the installation as a whole. It should be staffed with at least one full-time GIS professional.

335. Additional work stations should be available in at least the DPT, Master Planning, and the NRMO. These work stations would serve as local management tools for the respective areas. They would also allow rapid input and update of the installation data base. However, all new data would have to be screened by the GIS Section for accuracy and adherence to standards. This would insure that all users of the system operate with the same quality data.

336. EIA. The responsibility for coordinating EIA's should also rest with the LPOO. As the need arises for conducting an EIA, the office should task a responsible individual in the area affected to conduct the actual EIA. This individual should be provided with support from the GIS Section, and from individual offices throughout the installation as needed.

NRMO

337. As recommended here, the NRMO would have four major sections: (a) forest management; (b) fish and wildlife management; (c) agronomy and range management; and (d) cultural resources management. Each of these sections, depending on the physiography and natural resources of the respective installations, should be managed by a professional staff trained and experienced in their respective technical fields. These staffs should report to a common supervisor, the Natural Resources Manager, who would be responsible for insuring that equal consideration is given to all four of the major sections listed above. All of these sections and the Natural Resources Manager should coordinate closely among themselves, as well as with the Soil Conservation Section of the LPOO. Integrated, cooperative programs should be emphasized to insure that resource conflicts are minimized and that positive benefits are optimized. The responsibilities of the Natural Resources Manager should be

to: (a) set overall program goals and objectives based on legal and regulatory mandates, installation military training objectives, and advice and recommendations from his staff; (b) supervise the staff to insure the accomplishment of these goals and objectives in a coordinated manner; (c) coordinate with the EMO and the LPOO to insure that natural resources management viewpoints are adequately considered in the short- and long-range installation-level planning process; (d) coordinate with these offices to insure that the NRMO is in compliance with their guidelines; and, (e) provide for the selection and training of qualified individuals to perform these natural resource management programs.

338. Forestry Section. The Forestry Section should be primarily responsible for the planning, management, and protection of the woodland resources of the installation. This section should be organized as needed under the direction of one supervising forester who would be on an equal plane with the other staff officers within the NRMO, and who would report directly to the Natural Resources Manager.

339. Fish and Wildlife Section. The Fish and Wildlife Section should be primarily responsible for the planning, management, and protection of the fish and wildlife resources of the installation. This section should be led by a supervisory wildlife biologist who is assisted by a fisheries biologist, a wildlife biologist responsible for game species, and a wildlife biologist responsible for non-game and endangered species. As in the forestry section, these individuals should be supported by an appropriate staff of technicians and laborers sufficient to accomplish the workload. As above, the supervisory wildlife biologist would report directly to the Natural Resources Manager.

340. The non-game wildlife biologist would be the endangered species specialist for the installation, both for animal and plant species. It is felt that this function should be placed under the NRMO rather than the Environmental Office, as this placement would allow for an active program of management rather than a passive program of restrictions. This individual, and staff as needed, would be responsible for inventory, management, coordination among programs (e.g., forestry, game management, and military training), and monitoring functions associated with endangered species populations and habitats.

341. Agronomy and Range Section. The Agronomy and Range Section would be responsible for the planning, management, and protection of agricultural

and range resources of the installation. This section should be led by a supervisory agronomist or range conservationist depending on the type and amount of the respective resources found on the installation. As above, this section should be adequately staffed to accomplish it responsibilities, and the section leader should report directly to the Natural Resources Manager.

342. Cultural Resources Section. The Cultural Resources Section should be responsible for the planning, management, and protection of the archaeological and historical resources of the installation. This function should be transferred from the NRO because it is an "element of the land"; it is so closely affected by, and also affects, the other elements of natural resources management that more integrated and effective management of the cultural resources could be accomplished with this organization.

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Table 1

Initial Primary and Secondary Allocations for Northwest Region Compartments of Fort Benning, GA Before Resolution of Conflicts

Compartment	Wildlife (RCW, GT)	Arch/Hist Sites	Loblolly Pine	Unit Vehicle	Unit Infantry (Foot)	Possible Subcompt	Total P	Total S
M11		S		P	P	M	2	1
M12		S		S	S	AH	0	3
N01	S	S	P	P	P	AH	3	2
N02			P	S	P		2	1
002				S	S		0	2
003	P	S		S	S	RCW & GT	1	3
004	S			S	S	GT	0	3
005			P	P	S		2	1
006	S		P	P	P	GT	3	1
007		S	P	S	S	AH	1	3
008	S	S		S	P	RCW & GT	1	3
009		S		S	S		0	3
010	S			P	S	RCW & GT	1	2
011		S		S	S		0	3
012				S	S		0	2
013	S	S		S	S	RCW & M	0	4
014	S	S	P	P	S	RCW	2	3
015	P	S	S	P	S	RCW,AH,M	2	3
Total P's	2	0	6	7	5		20	
Total S's	7	11	1	11	13			43
Totals	9	11	7	18	18		63	

Note: P = primary; S = secondary; AH = archeological/historical; RCW = red-cockaded woodpecker; GT = gopher tortoise; M = military.

Table 2

Compatibilities and Potential Conflicts Between Natural Resource and Military Allocations (Partial)

Allocations	Wildlife RCW	Wildlife GT	Arch/Hist Sites	Loblolly Pine	Unit Vehicular Training	Unit Infantry Training
Wildlife						
RCW	NA	C	C	C	I	C†
GT	C	NA	C	C	I	C†
Arch/hist sites	C	C	NA	P**	I	C†
Loblolly pine	P**	P**	P**	NA	P††	C
Unit vehicular training	I	I	I	P††	NA	I
Unit (foot) infantry	C†	C†	C†	C	I	NA

Note: RCW = red-cockaded woodpecker: GT = gopher tortoise; Arch/hist = archaeological/historical sites; C = compatible; I = incompatible; P = possibly compatible.

* Possibly compatible under specified conditions; potential conflicts exist but can be modified or rearranged for compatibility--resource management decisions needed.

** Resource management decisions needed: possibly compatible if timber harvests are not within the actual designated arch/hist. sites or if non-destructive harvesting techniques are used--use subcompartments if needed.

† Scale-dependent--compatible in large areas (compartments and large stands) but not suitable in small areas (e.g., avoid bivouac establishment in sensitive wildlife food plot)--avoid direct intensive disturbance.

†† Possibly compatible if timber harvests are used to enhance training activity--certain cutting practices may conflict with specific activities. Also, possibly compatible based on spacing and age vs. training needs, i.e., widely spaced stands and/or older trees are less susceptible to being run over.

Table 3

Semi-Final Primary and Secondary Allocations for Northwest Region Compartments of Fort Benning, Georgia after Resolution of Conflicts (Partial)

Compartment	Wildlife (RCW, GT)	Arch/Hist Sites	Loblolly Pine	Unit Vehi-cle	Unit Infantry (Foot)	Possible Subcompt	Total P	Total S
M11		S		S	P	M	1	2
M12		S		S	S	AH & RCW	0	3
N01	S	S	P		P		2	2
N02			P		P		2	0
002				S	S		0	2
003	P	S			S		1	2
004	S			S	S	GT	0	3
005			S	P	S		1	2
006	S		P	S	P	GT	2	2
007		S	P		S		1	2
008	S	S			P	GT	1	2
009		S		S	S		0	3
010	S			P		RCW & M	1	1
011		S					0	1
012				S	S		0	2
013	S	S		S	S	RCW	0	4
014	S	S	P	P	S	RCW	2	3
015	P	S	S				1	2
Total P's	2	0	5	3	5		15	
Total S's	7	11	2	8	10			38
Totals	9	11	7	11	15		53	

Note: P = primary; S = secondary; GT = gopher tortoise; M = military; AH = archeological/historical; RCW = red-cockaded woodpecker.

Table 4

Total Acreage and Proportional Extent for the 10 Soil Categories and the 6 Soil Management Classes on the Fort Benning Military Reservation

Soil Management Class	Soil Category	Total Acreage	%
Streamside management areas	Ravines	2,366	1.6
	Minor bottoms	12,396	8.5
	Swamps	138	<0.1
		14,762	10.1
Bottomland hardwoods	Major bottoms	3,931	2.7
		3,931	2.7
Pine management, high potential	Terraces	11,499	7.9
	Upland, high potential	4,314	3.0
		15,813	10.9
Pine management, medium potential	Upland, medium potential (clay)	35,379	24.2
	Upland, medium potential (sand)	19,274	13.2
		54,653	37.4
Longleaf pine management areas	Upland, medium potential (deep sand)	36,690	25.0
		36,690	25.0
Scrub oak/ longleaf pine	Upland, low potential	20,344	13.9
		20,344	13.9
Totals		146,331	100%

Table 5

Acreages of Mapped Soil Series and Soil Categories, by Counties, on the Fort Benning Military Reservation

Soil Category	Soil Series	Chattahoochee County	Muscogee County	Russell County	Fort Benning Total
Ravines	Pelham	0	2,366	0	2,366
					2,366
Minor bottoms	Bibb	6,410	4,500	0	10,910
	Chastain	1,486	0	0	1,486
					12,396
Major bottoms	Bethera	0	0	532	532
	Bruno	0	0	320	320
	Chewacla	0	814	0	814
	Congaree	0	173	0	173
	Toccoa	0	2,252	0	2,252
					4,091
Swamps	Hydraquents	0	138	0	138
					138
Terraces	Annemaine	0	0	1,740	1,740
	Bigbee-Ochlockonee	793	0	0	793
	Cahaba	0	0	810	810
	Dogue	0	210	0	210
	Eunola	452	1,749	0	2,201
	Ochlockonee	2,076	0	0	2,076
	Rains	0	0	239	239
	Riverview and Bruno	0	0	1,117	1,117
	Wahee	0	275	0	275
	Wickham	0	44	1,994	2,038
					11,499
Upland, high potential	Dothan	319	717	0	1,108
	Orangeburg	538	423	879	1,840
	Red Bay	0	0	234	234
	Stilson	0	1,132	0	1,132
					4,314
Upland, medium potential (clay)	Esto	619	3,630	66	4,315
	Nankin	30,041	0	0	30,041
	Susquehanna	0	1,023	0	1,023
					35.379

(Continued)

Table 5 (Concluded)

Soil Category	Soil Series	Chattahoochee County	Muscogee County	Russell County	Fort Benning Total
Upland, medium potential (sand)	Ailey	2,518	3,312	0	5,830
	Cowarts-Ailey*	5,155	0	224	5,379
	Fuquay	963	0	1,119	2,082
	Lucy	830	0	0	830
	Wagram	0	5,153	0	5,153
					19,274
Upland, medium potential (deep sand)	Troup	21,265	15,425	0	36,690
					36,690
Upland, low potential	Cowarts-Ailey*	9,573	0	417	9,990
	Cowarts-Blanton	0	0	987	987
	Lakeland	4,156	387	0	4,543
	Vaucluse	0	4,824	0	4,824
					20,344
Total					146,491

* These soils were mapped as an undifferentiated group consisting of approximately 65% Cowarts soils and 35% Ailey soils. The underlined name indicates the appropriate series and approximate acreage for the respective soil category.

Table 6

Approximate Acreage of Forest Types by County for the Fort Benning Military Reservation

Forest Type	Chattahoochie County	Muscogee County	Russell County	Fort Benning Total
9	889	313	132	1,334
10	5,266	1,327	299	6,892
12	53	0	0	53
13	1,939	1,264	184	3,387
21	2,733	1,628	101	4,462
21P	191	188	0	379
22	187	521	216	924
22P	108	332	208	648
25	15,750	4,814	1,167	21,713
25P	160	33	78	271
31	13,546	13,263	1,746	28,555
31P	3,105	841	482	4,428
32	1,509	13	179	1,701
41	2,300	813	277	3,390
42	3,879	837	103	4,819
44	181	0	0	181
46	4,310	1,340	374	6,024
48	203	0	18	221
49	802	316	0	1,118
51	81	0	0	81
53	2,883	179	294	3,356
54	0	14	0	14
56	1,394	302	111	1,807
57	2,662	306	13	2,981
58	1,601	973	99	2,673
60	67	0	3	70
62	3,810	5,763	1,203	10,776
63	121	29	0	150
64	254	166	0	420
68	2,194	807	167	3,168
71	0	0	22	22
80	49	0	80	129
98	492	132	311	935
99	830	242	936	2,008

Table 7

Overview of a Proposed Preliminary Allocation of Lands to Various Natural Resource Management Uses at Fort Benning, GA

Soil Management Class	Forest Management Working Group	Gross Acres	Misc. Uses (15%)	"Net" Acres	Old Growth Acres (10%)	Rotation Acres	Timber Harvest/Year acres				
							Regen.	Thin	SW 1	SW 2	Total
Streamside management areas	Streamside management	14,762	2,214	12,548	12,548	0					0
Bottomland hardwoods	Bottomland hardwoods	3,931	590	3,341	341	3,000					
Pine management, high potential	High-intensity pine management	15,813	2,524	13,289	0	13,289	332	996			1,328
Pine management, medium potential	Medium-intensity pine management	54,653	8,520	46,133	4,613	41,520	519	2,595			3,114
Longleaf pine management areas		36,690	5,500								
	Longleaf pine			22,965	2,965	20,000	200	800	200	200	1,400
	Pine-hardwood			15,549	1,555	13,994	175	875			1,050
"Scrub oak"/ longleaf pine		20,344	4,509								
	Scrub oaks			4,339	4,339	0					0
	Upland hardwoods			4,172	4,172	0					0
		146,193		146,193	30,533	91,803	1,266	5,266	200	200	6,892

Table 8

Recommended Distribution of Age Classes by Working Groups for the Fort Benning Military Reservation, GA (Preliminary)

Working Group	Rotation Length years	Age Classes 1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	Permanent Old Growth	Total
High-intensity pine management	40	3,322	3,322	3,322	3,322	0	0	0	0	0	0	0	13,289
Medium-intensity pine management	80	5,190	5,190	5,190	5,190	5,190	5,190	5,190	5,190	0	0	4,613	46,133
Pine-hardwoods	80	1,749	1,749	1,749	1,749	1,749	1,749	1,750	1,750	0	0	1,555	15,549
Longleaf pine	100	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,965	22,965
Totals		12,261	12,261	12,261	12,261	8,939	8,939	8,940	8,940	2,000	2,000	9,133	97,936

Table 9

Preliminary Allocation of Individual Forest Types to Forest Management Working Groups at Fort Benning, GA

Working Group	Forest Type and Code Number
Streamside management area	54 - White oak
	56 - Yellow poplar-white oak-laurel/ water oak
	68 - Sweetbay-swamp tupelo-red maple
	71 - Black ash-American elm-red maple
Bottomland hardwoods	62 - Sweetgum-water oak-willow oak
	64 - Laurel oak-willow oak
High-intensity pine management	31 - Loblolly pine
	31P - Loblolly pine plantations
	58 - Sweetgum-yellow poplar
	60 - Sweetgum
	63 - Sugarberry-American elm-green ash
Medium-intensity pine management	25 - Mixed pine
	25P - Mixed pine plantations
	31 - Loblolly pine
Longleaf pine	10 - Yellow pine-upland hardwoods
	13 - Loblolly pine-hardwood
	21 - Longleaf pine
	21P - Longleaf pine plantations
	22 - Slash pine
	22 P - Slash pine plantations
	25 - Mixed pine
	32 - Shortleaf pine

(Continued)

Table 9 (Concluded)

Working Group	Forest Type and Code Number
Longleaf pine (cont.)	98 - Undrained flatwoods
	99 - Brush
Pine-hardwoods	9 - Yellow pine-bottomland hardwood
	12 - Shortleaf pine-oak
	41 - Cove hardwoods-yellow pine
	42 - Upland hardwood-yellow pine
	44 - Southern red oak-yellow pine
	46 - Bottomland hardwood-yellow pine
	48 - Northern red oak-hickory-yellow pine
Scrub oaks	49 - Southern scrub oaks-yellow pine
	57 - Scrub oak
Upland hardwoods	51 - Post oak-black oak
	53 - White oak-red oak-hickory
	80 - Blackgum

Table 10

Proposed Regulation Progress Table (Preliminary) for the High-Intensity Pine Management Working Group at Fort Benning, GA

	Acres by Age Classes										
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Perm. Old Growth	Total
Desired age class distribution	3,322	3,322	3,322	3,323	0	0	0	0	0	0	13,289*
Present age distribution**	4,180	464	1,461	1,022	2,456	1,673	1,423	367	243	0	13,289
Regenerate this period						1,289	1,423	367	243		3,322
Distribution end 1st period						384	0	0	0		
Distribution start 2nd period	3,322	4,180	464	1,461	1,022	2,456	384	0	0	0	13,289
Regenerate this period					482	2,456	384				3,322
Distribution end 2nd period					540	0	0				
Distribution start 3rd period	3,322	3,322	4,180	464	1,461	540	0	0	0	0	13,289
Regenerate this period			857	464	1,461	540					3,322
Distribution end 3rd period			3,323	0	0	0					
Distribution start 4th period	3,322	3,322	3,322	3,323	0	0	0	0	0	0	13,289
Regenerate this period				3,323							3,323
Distribution end 4th period				0							

Note: High-intensity pine management working group rotation = 40 years. Permanent old growth objective = 0 acres.

* This value is based on the "net acres" column in Table 7.

** The present age class distribution given here is approximate only. More precise values should be developed using the forest type allocations in Table 9 in conjunction with GIS data on soil management classes and LANDMENU data on age class distributions for the respective forest types.

Table 11

Proposed Regulation Progress Table (Preliminary) for the Medium-Intensity Pine Management Working Group at Fort Benning, GA

	Acres by Age Classes										
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Perm. Old Growth	Total
Desired age class distribution	5,190	5,190	5,190	5,190	5,190	5,190	5,190	5,190	0	4,613	46,133*
Present age distribution**	423	987	5,258	9,504	9,918	9,049	7,123	2,219	1,652	0	46,133
Regenerate this period						2,971	1,000	1,219			5,190
Distribution, end of 1st period						6,078	6,123	1,000	0	1,652	
Distribution, start 2nd period	5,190	423	987	5,258	9,504	9,918	6,078	6,123	1,000	1,652	46,133
Regenerated this period								5,190			5,190
Distribution, end 2nd period										2,652	
Distribution, start 3rd period	5,190	5,190	423	987	5,258	9,504	9,918	6,078	933	2,652	46,133
Regenerated this period								5,190			5,190
Distribution, end 3rd period								888	0	3,585	
Distribution, start 4th period	5,190	5,190	5,190	423	987	5,258	9,504	9,918	888	3,585	46,133
Regenerated this period								5,190			5,190
Distribution, end 4th period								4,728	0	4,473	

(Continued)

Note: Medium-intensity pine management working group rotation = 80 years. Permanent old growth objective = 4,631 acres.

* This value is based on the "net acres" column in Table 7.

** The present age class distribution given here is approximate only. More precise values should be developed using the forest type allocations in Table 9 in conjunction with GIS data on soil management classes and LANDMENU data on age class distributions for the respective forest types.

Table 11 (Concluded)

	Acres by Age Classes										
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Perm. Old Growth	Total
Distribution, start 5th period	5,190	5,190	5,190	5,190	423	987	5,258	9,504	4,728	4,473	46,133
Regenerated this period								5,190			5,190
Distribution, end 5th period								4,314	4,588	4,613	
Distribution, start 6th period	5,190	5,190	5,190	5,190	5,190	423	987	5,258	8,902	4,613	46,133
Regenerated this period								0	5,190		5,190
Distribution, end 6th period								5,258	3,712	4,613	
Distribution, start 7th period	5,190	5,190	5,190	5,190	5,190	5,190	423	987	8,970	4,613	46,133
Regenerated this period								0	5,190		5,190
Distribution, end 7th period								987	3,780	4,613	
Distribution, start 8th period	5,190	5,190	5,190	5,190	5,190	5,190	5,190	423	4,767	4,613	46,133
Regenerated this period								423	4,767		5,190
Distribution, end 8th period								0	0	4,613	
Distribution, start 9th period	5,190	5,190	5,190	5,190	5,190	5,190	5,190	5,190	0	4,613	46,133
Regenerated this period								5,190			5,190
Distribution, end 9th period											

Table 12

Proposed Regulation Progress Table (Preliminary) for the Pine-Hardwood Working Group at Fort Benning, GA

	Acres by Age Classes										
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Perm. Old Growth	Total
Desired age class distribution	1,749	1,749	1,749	1,749	1,749	1,749	1,750	1,750		1,555	15,549*
Present age distribution**	73	126	1,030	2,595	2,642	3,264	2,935	1,840	1,044	0	15,549
Regenerated this period								1,749			1,749
Distribution, end of 1st period								91	0	1,044	
Distribution, start 2nd period	1,749	73	126	1,030	2,595	2,642	3,264	2,935	91	1,044	15,549
Regenerated this period								1,749			1,749
Distribution, end 2nd period								1,186	0	1,135	
Distribution, start 3rd period	1,749	1,749	73	126	1,030	2,595	2,642	3,264	1,186	1,135	15,549
Regenerated this period								1,749			1,749
Distribution, end 3rd period								1,515	766	1,555	
Distribution, start 4th period	1,749	1,749	1,749	73	126	1,030	2,595	2,642	2,281	1,555	15,549
Regenerated this period								1,749			1,749
Distribution, end 4th period								893			
Distribution, start 5th period	1,749	1,749	1,749	1,749	73	126	1,030	2,595	3,174	1,555	15,549
Regenerated this period								1,749			1,749
Distribution, end 5th period								846			

(Continued)

Note: Pine-hardwood working group rotation = 80 years. Permanent old growth objective = 1,555 acres.

* This value is based on the "net acres" column in Table 7.

** The present age class distribution given here is approximate only. More precise values should be developed using the forest type allocations in Table 9 in conjunction with GIS data on soil management classes and LANDMENU data on age class distributions for the respective forest types.

Table 12 (Concluded)

	Acres by Age Classes										
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Perm. Old Growth	Total
Distribution, start 6th period	1,749	1,749	1,749	1,749	1,749	73	126	1,030	4,020	1,555	15,549
Regenerated this period								1,030	719		1,749
Distribution, end 6th period								0	3,301		
Distribution, start 7th period	1,749	1,749	1,749	1,749	1,749	1,749	73	126	3,301	1,555	15,549
Regenerated this period								126	1,624		1,750
Distribution, end 7th period								0	1,677		
Distribution, start 8th period	1,750	1,749	1,749	1,749	1,749	1,749	1,749	73	1,667	1,555	15,549
Regenerated this period								73	1,677		1,750
Distribution, end 8th period								0	0		

Table 13

Proposed Regulation Progress Table (Preliminary) for the Long-Leaf Working Group at Fort Benning, GA

	Acres by Age Classes													
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	100+	Unclass.	Perm. Old Growth	Total
Desired age class distribution	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000		0	2,965	22,965*
Present age distribution**	80	616	3,879	2,601	3,441	3,202	4,018	1,714	714	286	78	2,336	0	22,965
Regenerated this period												2,000		2,000
Distribution, end of 1st period											0	336	78	
Distribution, start 2nd period	2,000	80	616	3,879	2,601	3,441	3,202	4,018	1,714	1,714	286	336	78	22,965
Regenerated this period									1,164	500		336		2,000
Distribution, end 2nd period									550	214		0	364	
Distribution, start 3rd period	2,000	2,000	80	616	3,879	2,601	3,441	3,202	4,018	550	214	0	364	22,965
Regenerated this period									2,000					2,000
Distribution, end 3rd period									2,018				578	
Distribution, start 4th period	2,000	2,000	2,000	80	616	3,879	2,601	3,441	3,202	2,018	550	0	578	22,965
Regenerated this period									1,000	1,000			1,128	2,000
Distribution, end 4th period									2,202	1,018				
Distribution, start 5th period	2,000	2,000	2,000	2,000	80	616	3,879	2,601	3,441	2,202	1,018	0	1,128	22,965
Regenerated this period									617	1,383				2,000
Distribution, end 5th period									2,824	819			2,146	
Distribution, start 6th period	2,000	2,000	2,000	2,000	2,000	80	616	3,879	2,601	2,824	819	0	2,146	22,965
Regenerated this period										2,000				2,000
Distribution, end 6th period										824			2,965	
Distribution, start 7th period	2,000	2,000	2,000	2,000	2,000	2,000	80	616	3,879	2,601	824	0	2,965	22,965
Regenerated this period										1,176	824			2,000
Distribution, end 7th period										1,425	0			
Distribution, start 8th period	2,000	2,000	2,000	2,000	2,000	2,000	2,000	80	616	3,879	1,425	0	2,965	22,965
Regenerated this period										1,575	1,425			2,000
Distribution, end 8th period										3,304	0			
Distribution, start 9th period	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	80	616	3,304	0	2,965	22,965
Regenerated this period											2,000			2,000
Distribution, end 9th period														
Distribution, start 10th period	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	80	1,920	0	2,965	22,965
Regenerated this period										80	1,920			2,000
Distribution, end 10th period										0	0			

Note: Longleaf-pine working group rotation = 100 years. Permanent old growth objective = 2,965 acres.

* This value is based on the "net acres" column in Table 7.

** The present age class distribution given here is approximate only. More precise values should be developed using the forest type allocations in Table 9 in conjunction with GIS data on soil management classes and LANDMENU data on age class distributions for the respective forest types.

Table 14

Proposed Annual Timber Harvesting Plan for Fort Benning (Preliminary)

Forest Management Working Group	Rotation Acres	Timber Harvest/Year, acres				
		Regenerate	Thin	Shelter-wood 1	Shelter-wood 2	Total
Streamside management areas	0					0
Bottomland hardwoods	3,000					
High-intensity pine management	13,289	332	996			1,328
Medium-intensity pine management	41,520	519	2,595			3,114
Longleaf pine	20,000	200	800	200	200	1,400
Pine-hardwood	13,994	175	875			1,050
Scrub oaks	0					0
Upland hardwoods	0					
Totals	91,803	1,226	5,266	200	200	6,892

Table 15

Time Schedule for Achieving Old-Growth Objective to Support RCW Colonies at Fort Benning, GA (Preliminary)

Year	Pine (Medium) Working Group Acres	%	Pine-Hardwood Working Group Acres	%	Longleaf Pine Working Group Acres	%	Fort Benning Total Acres	%	Potential 40-Acre RCW Colony Sites
1990	1,652	36	1,044	67	78	3	2,774	30	69
2000	1,652	36	1,135	73	78	3	2,864	31	72
2010	2,652	58	1,555	100	364	12	4,571	50	114
2020	3,585	78			578	19	5,718	63	143
2030	4,473	97			1,128	38	7,156	78	179
2040	4,613	100			2,146	73	8,314	91	208
2050					2,965	100	9,133	100	228

Note: Old-growth objective = 9,133 acres of perpetual yellow pine old-growth stands.

APPENDIX A: FIELD SAMPLING PROCEDURES

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Forest Stand Delineation and Characterization

1. One of the major objectives of natural resource management sampling at Fort Benning was to delineate and characterize forest stands. Prior to the initiation of this project, areas of land ranging from roughly 250 to 2,500 acres had been designated as training areas for military needs; these same areas had also been designated as compartments for forest management purposes. However, most of these lands at Fort Benning had not been subdivided into smaller, more manageable units or forest stands, based on the existing vegetation type and the potential productivity of the site. This task was accomplished through the following procedures.

2. The stand delineation process consisted of three phases: (a) a preparatory or "setup" phase; (b) a field-sampling phase; and, (c) a completion or "wrap-up" phase. Each of these phases requires several steps. During the preparatory phase, the sampling team gathers necessary materials, reviews these materials, performs a preliminary on-the-ground field inspection of the area, prepares field maps and data sheets, and schedules access to the area through the Range Control Office. The field-sampling phase consists of following transects through the area and collecting forestry and wildlife habitat data on sample plots. In the completion phase, the field data are reduced to forest type, condition class, site potential, and wildlife habitat information; stand boundaries are drawn; and, summary forms are completed to characterize each stand delineated. Typical activities necessary to accomplish each of these phases are presented below.

Preparatory phase

a. Assemble necessary aerial photos and topographic maps.

b. Define the compartment boundaries to insure that the boundaries of all adjacent compartments correspond with each other.

c. Locate landmarks (road intersections, clearings, wildlife openings, etc.) on aerial photos that can be used as starting points for field transects.

d. Conduct a pre-inventory field inspection of the compartment in order to pinpoint the on-the-ground location of all landmarks to be used as starting points for field transects. Also conduct a preliminary reconnaissance to develop an overview of the condition and types of vegetation present in the compartment, the

location of military training facilities, and any other features that would impact on the field sampling scheme.

e. Place transect lines on aerial photos and topographic maps of the compartment. These transect lines should include starting points, magnetic azimuths or bearings, turning points, and individual plot locations. Prepare a master and enough copies to provide field maps for each sampling crew.

f. Fill out the header data (i.e., compartment number, line or transect number, and plot number) on the data sheets for each transect.

Field sampling phase

3. Field sampling was divided into two categories: lands previously inventoried and lands not previously inventoried. Most of the lands on the installation had not been previously inventoried for natural resources and needed to be sampled for both timber variables and for wildlife variables. Some of the installation lands, however, had already been sampled for timber, and thus they required a different procedure for collecting the wildlife variables. Each of these sampling procedures is explained below.

4. Timber and wildlife sampling. The procedures used in this study were a modification of those already used at Fort Benning prior to the start of this project. Fort Benning personnel were using a continuous inventory of stand conditions adapted from the system employed by the US Forest Service (USFWS). This system was modified by personnel at the US Army Engineer Waterways Experiment Station (WES) to include the recording of tree species and diameter at breast height (dbh) for sample trees selected by the basal area (BA) prism in order to develop timber volume estimates from plot data. Also, a number of wildlife habitat variables were added to the sampling procedure. These procedures are explained below.

a. Commencing at a transect starting point, pace 200 ft along a specified magnetic bearing to the first sampling point.

b. Record the compartment number, line (transect) number, and plot number (this data should already be on the data sheet from the preparatory phase above).

c. Use a 59 ft/acre BAF (English) wedge prism to select individual trees to sample for species and dbh. Record the appropriate species code and dbh (in inches) for each sample tree $\geq$ 4.0 in. dbh (including snags, which are identified simply as pines or hardwoods).

d. Summarize and record the BA per acre (in square feet per acre) for sampled pine trees.

e. Summarize and record the BA per acre for sampled hardwood trees.

f. Determine the forest type present and record the appropriate code.

g. Determine the stand condition class and record the appropriate code.

h. If the plot conditions warrant a possible silvicultural treatment, determine the appropriate recommendation and record the code for the method of cut.

i. Determine the operability of the stand conditions at this plot and record the appropriate code.

j. Determine the recommended management type best suited to the current and potential site conditions, and record the appropriate code.

k. Record any features unique to the plot and/or plot area to assist in determining stand boundary breaks, potential erosion problems, etc. (i.e., "At plot 18, found old erosion gullies from past seed-tree cut..." or "...heading down steep slope toward gum swamp..."). These types of notes are often invaluable.

l. On every other plot (i.e., 50 percent coverage) select a typical dominant or co-dominant tree that appears to have developed under "normal" conditions (i.e., one somewhere between the extremes of free-standing open-grown development, and dense stagnated conditions. Measure and record the total height and current age of the tree to the nearest foot and year, respectively; record these data.

(Note: Steps m.-o. are based on the following sampling protocol.)

(1) Ground cover is measured in accordance with the method outlined by Daubenmire* (1959) and the appropriate cover class code is recorded for each category of interest.

(2) Ground cover measurements are taken on square quadrats that are 0.5 m on each side or 0.25 sq m in total area. These quadrats are marked with four divisions on one set of parallel sides, and they are marked with five divisions on the other set of parallel sides in order to allow the observer to mentally subdivide the quadrat into 20 equal blocks. Each of the blocks represents 5 percent of the area covered by the quadrat.

(3) The vegetation on six to eight of these 0.25-m quadrats is measured and the data recorded for each plot.

m. Sample the plot to determine the average coverage of evergreen plant species valuable as winter browse foods for white-tailed deer; record the appropriate codes.

n. Sample the plot to determine the average coverage of herbaceous plants valuable as food producers for the bobwhite quail; record the appropriate codes.

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* See References at the end of the main text.

o. Sample the plot to determine the average coverage of herbaceous plants more than 8 in. tall and less than 25 in. tall that serve as a vegetative substrate for insects that would, in turn, provide a potential food source for eastern wild turkey chicks and poults. Record the appropriate codes.

(Note: Steps p.-r. are based on a plot radius of 30 ft.)

p. Record the presence or absence of one or more clumps of vegetation (live or dead) that would function as potential escape cover for bobwhite quail.

q. Record the presence or absence of one or more clumps of dead grass of appropriate height, density, and areal extent that would function as potential nesting grass for bobwhite quail.

r. Record the presence or absence of one or more stems of woody, soft-mast-producing species (=> 1 in. dbh) that could serve as a potential food source for eastern wild turkeys.

(Note: Steps s.-v. are based on conditions in the immediate vicinity of the plot, including areas generally visible from anywhere on the plot or along the line to the next plot.)

s. Record the presence of any tree visible from the plot center that shows evidence of having been used as a cavity tree by red-cockaded woodpeckers.

t. Record the presence of any gopher tortoise burrow occurring on the plot, within sight of the plot, or within sight of the transect line between this plot and the next plot.

u. Record the last two digits of the most recent year of burn, as estimated from field evidence occurring on or near the plot, of any prescribed burning or wildfire.

v. Record any pertinent comments relative to the plot or stand conditions, the weather conditions, or the overall sampling scheme (i.e., occurrence of turning points and bearings of new lines, etc.).

w. Pace 200 ft along the transect and sample the next plot.

5. Wildlife sampling. The procedures outlined here are an abbreviated version of the sampling procedures described above. In instances where the timber data had already been gathered, the wildlife habitat variables were sampled by themselves. The wildlife plot sampling techniques outlined above were used as already described; the only significant difference between the procedures was the system used to locate plots.

6. When forest stands had already been delineated and the timber conditions characterized, the sampling crew subjectively placed an appropriate number of plots in each stand. The crews took advantage of the road and trail network of the compartment to access each stand (i.e., whenever possible, the crews drove the roads and stopped as necessary to walk through adjacent stands

taking plot data). Each stand was adequately sampled (i.e., one plot per 5 acres), but transect lines were not used.

7. At each sampling point or plot, all wildlife variables were sampled as described above. As necessary, a prism sample was conducted to obtain tree species and dbh data. This was required only where Fort Benning personnel had previously done the timber sampling due to the difference in sampling techniques used.

Completion phase

8. The completion phase is carried out as follows:

a. Make a preliminary delineation of forest types and stand boundaries on aerial photographs and topographic maps.

b. Construct a preliminary stand summary table that lists the plot data used to tentatively identify each stand.

c. Return to the field to sample selected new plots required to "fine-tune" the initial stand boundaries.

d. Complete the final compartment map showing all stand boundaries (with stand number, forest type, condition class, and age), roads, wildlife openings, military sites, inoperable areas, etc.

e. Analyze final boundaries with a planimeter to determine individual stand acreages and total compartment acreages.

f. Prepare stand and compartment summary tables.

HSI Models

9. The US Fish and Wildlife Service's (USFWS) Habitat Suitability Index (HSI) model format was used as the basis for inventorying wildlife habitat conditions at Fort Benning. Published models were available for three species (northern bobwhite quail, eastern gray squirrel, and eastern wild turkey), while an unpublished model was used for the white-tailed deer. As no model was available for the red-cockaded woodpecker, Dr. T. H. Roberts and Ms. L. J. O'Neil of WES developed an HSI model for this species based on draft information supplied by Dr. M. R. Lennartz of the USFS.

10. These HSI models were evaluated, refined, and modified to produce a set of habitat variables compatible with the large-scale sampling efforts to be conducted at Fort Benning. This process generally involved reducing the number of different variables to be sampled for each mode. This was accomplished by: (a) combining similar variables from different models into one common variable suitable for use in all appropriate models; (b) replacing

complex and/or sampling intensive variables with ones designed to measure similar relationships; and, (c) deleting certain "fine-tuning" variables that were felt to contribute a relatively small amount of information for the sampling effort required. The details of this modification process for each HSI model are presented below.

Eastern gray squirrel

11. Original model variables. The original set of variables, from Allen (1982),* were:

V1 = percent canopy closure of trees that produce hard mast that are ≥ 10 in. dbh.

V2 = diversity of tree species that produce hard mast.

V3 = percent tree canopy closure.

V4 = average dbh of overstory trees.

V5 = percent shrub crown cover.

12. Original life requisites. Tabulated data for these variables were processed through the respective suitability index (SI) curves to derive SI scores, which were then mathematically combined to produce scores for various life requisites. The recommended life requisite equations were:

Winter food $(SIV1*SIV2)^{1/2}$

Cover/reproduction $(SIV3*SIV4)^{1/2} * SIV5$

13. Original HSI determination. The HSI for the gray squirrel equals the lower of the life requisite values.

14. Comments. A number of relatively small changes were made in this model. These changes are discussed by individual variables below.

15. V1. Crown closure was dropped as a variable and replaced with basal area, which is a concept more commonly used in standard forest inventory and management procedures. This value is tabulated by the LANDMENU program for each plot and an average for each stand is calculated.

16. The upper limit of hard mast basal area needed to produce an SI of 1.0 for this variable was set at 40 sq ft/acre. This value was obtained as follows:

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* See References at the end of the main text.

a. A recommended total hard-mast production of 130-150 lb/acre (Nixon, McClain, and Donohoe 1975).

b. An average hard-mast production rate of 3.5 lb/sq ft of basal area for hard-mast producers ≥ 10 in. dbh (Holbrook 1973).

c. BA/acre = (140 lb/acre)/(3.5 lb/sq ft) = 40 sq ft/acre.

17. V2. There are at least three approaches to determining species diversity of hard-mast-producing trees (HM). From most restrictive to least restrictive, these are:

a. Determine the average number of hard-mast species occurring within a stand. This is calculated as follows:

$$\text{Species diversity} = \frac{\text{Sum (\# different hard mast species} \geq \text{10 in. dbh occurring on each plot}}{\text{\# plots in a stand}}$$

For example, if a stand had five plots with hard-mast data as follows:

Plot	Number of Species ≥ 10 in. dbh	Species Diversity
1	3	11/5
2	2	
3	1	
4	0	2.2
5	5	
Total =	11	

b. Determine the total number of hard-mast species ≥ 10 in. dbh encountered over all plots within a stand. Each species would be counted only once, irrespective of how many times it occurred or how many individual stems were counted. The species diversity is a "count" of the different hard-mast species that occur throughout the stand. This is similar to species richness as used in species diversity calculations in the ecological literature.

c. Determine the total number of hard-mast species of any dbh that occur on the plots in the stand, as long as they are tallied by the 10-BAF prism. There is no size restriction for this approach; otherwise, it is the same as the second approach above.

18. The second approach was used in the LANDMENU program. The concept of species richness was considered to be appropriate here because the intent of V2 is to reflect the level of natural variability associated with hard-mast production. Species richness is a straightforward way to reflect the mix of different hard-mast species available within a stand. Also, the size of

constraint, ≥ 10 in. dbh, was used as the HSI was designed to measure the "current" habitat value, and trees < 10 in. dbh are not generally large enough to produce significant amounts of hard mast.

19. V3. The plot and stand values for this variable were estimated by a stand table approach using crown cover tables developed by Leak and Tubbs (1983).* The calculations were as follows:

a. All trees counted on a 10-BAF prism plot were assigned to one of three classes based on their respective crown size and shape. These classes were (1) narrow (for pines and similar conifers), (2) wide (for American beech), and (3) standard (for all other species).

b. Each tree was assigned a value for percent crown cover based on its respective crown class and dbh. A stand table (i.e., the number of stems per acre by dbh classes) was calculated using standard prism cruising plot expansion factors, and the crown cover values were multiplied and summed to give an estimate of the percent crown cover for the plot.

c. A stand average was calculated from plot data. This stand average was assigned an SI value from the appropriate SI graph.

20. V4. The average dbh for the stand was calculated by a stand table determination of the diameter of the tree of average basal area. This value is generally larger than the simple arithmetic mean of tree diameters, and was used because it more accurately reflects the true character of the stand overstory which is dominated by the larger stems.

21. V5. This variable was deleted. It served as a "modifier" in the original model (i.e., it could not improve an HSI score, it could only modify a score downward). It was felt that the relative presence or absence of understory shrub cover would not be a significant influence at Fort Benning when compared to the presence or absence of a hard-mast supply and reproductive cover.

22. Current model variables. Variables from the original model were modified and a new set of variables was developed, as follows:

V1 = BA of hard-mast producers ≥ 10 in. dbh.

V2 = species diversity of hard-mast-producing trees ≥ 10 in. dbh.

V3 = percent tree canopy closure.

V4 = average dbh of overstory trees.

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* See References at the end of the main text.

Suitability index curves for these variables are given in Figure A.

Current life requisites.

Winter food $(SIV1*SIV2)^{1/2}$

Cover/reproduction $(SIV3*SIV4)^{1/2}$

Current HSI determination. Same as in original model above.

Eastern wild turkey

23. Original model variables. The original set of variables, from Schroeder (1985b)*, were:

V1 = percent herbaceous canopy cover

V2 = average height of the herbaceous canopy (summer)

V3 = distance to forest or tree savanna cover types

V4 = number per acre and average dbh of hard-mast-producing trees ≥ 10 in. dbh

V5 = percent canopy closure of soft-mast-producing trees

V6 = percent shrub crown cover (food production)

V7 = percent shrub crown cover (behavioral)

V8 = percent of shrub crown cover comprised of soft-mast-producing shrubs

V9 = type of crop (agricultural)

V10 = over-winter crop management

V11 = percent tree canopy cover

V12 = average dbh of overstory trees

V13 = percent of forest canopy comprised of evergreens

V14 = percent of area providing equivalent optimum summer food/brood habitat

V15 = percent of area providing equivalent optimum fall, winter, spring food

V16 = percent of area providing equivalent optimum cover

24. Original life requisites:

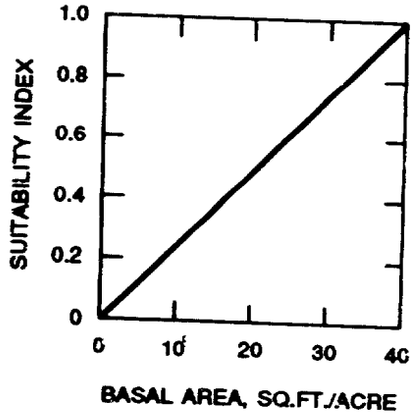
Summer food $(SIV1*SIV2)^{1/2} * SIV3$

Winter food (forests) $\frac{(SIV4+SIV5) + (SIV6*SIV8)}{2} * SIV7$

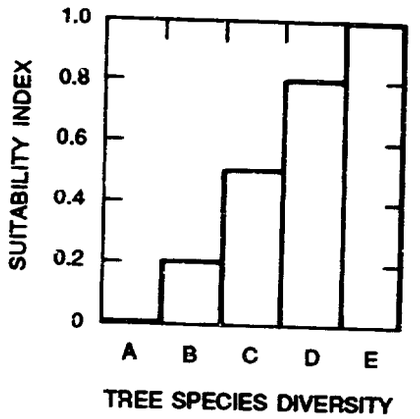
(shrublands) $\frac{SIV6 * SIV8)}{2} * (SIV7 * SIV3)$

(croplands) $SIV9 * SIV10 * SIV3$

Cover $SIV11 * SIV12 * SIV13$

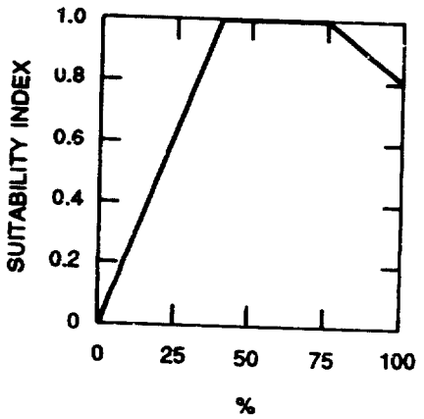


V_1 BASAL AREA OF HARD MAST PRODUCING TREES > 10" DBH

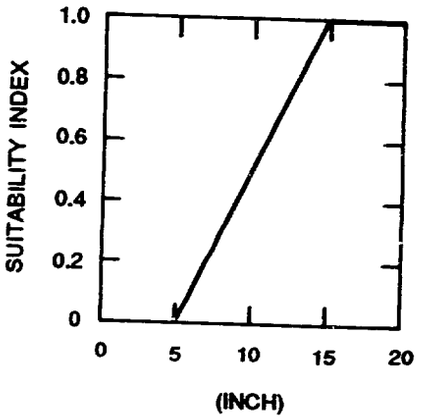


A) NONE PRESENT
B) 1 SPECIES PRESENT
C) 2 SPECIES PRESENT
D) 3 SPECIES PRESENT
E) 4 OR MORE SPECIES PRESENT

V_2 DIVERSITY OF TREE SPECIES THAT PRODUCE HARD MAST



V_3 PERCENT TREE CANOPY CLOSURE.



V_4 AVERAGE DBH OF OVERSTORY TREES.

Figure A1. Suitability index curves for the gray squirrel HSI model used in the LANDMENU Program for Fort Benning, GA

25. Original HSI determination. Life requisite values are calculated for summer food, winter food, and cover for each major cover type (i.e., forests, shrublands, and croplands) in the study area. These life requisite values are weighted based on the relative percent area in each cover type, and these weighted values are summed. An SI value for each weighted life requisite is calculated using the SI curves for variables 14-16. The HSI will equal the lowest of these SI values for variables 14-16.

26. Comments. The eastern wild turkey model has undergone a significant revision from 16 to 5 variables. Also, the procedures for deriving life requisite and HSI values have been changed. The rationale used in this process is explained below.

a. V1 and V2: These variables were combined to produce the current VA which reflects both the ground cover and height components of the original variables. The 8- to 24-in. criterion comes from the desirable heights reported in the original model for optimum turkey use of herbaceous understory.

b. V3: This variable was deleted because it was considered that escape cover would not be limiting in the forested environment at Fort Benning.

c. V4: This was replaced with the current V2 which measures the potential for hard-mast productivity. The current V2 in the turkey model is the same as the current V1 in the squirrel model.

d. V5, V6, V8: These variables were replaced with the current V4 which provides a measure of the potential for soft-mast production in a stand. The current V4 now acts as a positive modifier that supplements the hard-mast food value of a stand.

e. V7: This variable was deleted. When the Fort Benning sampling design was developed, the turkey model had not been published and this variable had not been included in the early drafts. This factor has not been addressed in the HSI's developed for Fort Benning.

f. V9 and V10: Both of these variables were deleted as there is no cropland at Fort Benning.

g. V11, V12, V13: These three variables were deleted as the availability of forest cover is not a limiting factor for wild turkeys at Fort Benning.

h. V14, V15, V16: These variables were not used as they are summary variables, and the HSI in the current model was calculated in a different manner.

27. Food SI. This life requisite currently reflects the value of a stand as a food source for turkeys. This is primarily influenced by the amount and reliability of hard-mast production, with soft mast and pines being

considered as positive supplements. Stands with high BA and diversity of hard-mast producers (i.e., trees ≥ 10 in. dbh) should reflect high SI values for potential food production. The food value of pine-dominated stands, with little or no hard-mast BA, is in their soft-mast and large-pine components. It was considered that these pure pine stands would have a maximum food value of 0.4 if they had sufficient BA of large trees (i.e., ≥ 50 sq ft/acre of pine trees ≥ 10 in. dbh), coupled with a high percentage (≥ 30 percent) of soft-mast producers.

28. Brood SI. This concept is based on the value of the stand as a potential source of insects as food for turkey poults. The current V1 reflects this value, which is based on the vegetative substrate available to produce insect biomass in a height zone (8 to 24 in.) that would be: (a) low enough for utilization by poults; (b) high enough to provide cover/concealment for adult turkeys; and, (c) not too high to limit adults in their ability to recognize potential danger at a distance.

29. HSI. The eastern wild turkey HSI is considered to be the greater of the stand food SI or brood SI. This is a stand HSI value which reflects that stands, even relatively large stands of 200-300 acres, encompass only a small part of an individual turkey's home range (2,000-3,000 acres) or of a flock's acreage needs (5,000-6,000 acres). This HSI indicates the positive value of the stand to turkeys as either a food source for juveniles and adults, or as a food source for turkey poults. This approach seems appropriate for Fort Benning where cover should not be a limiting factor since the entire installation is essentially forested and provides at least minimum cover requirements.

30. Stand age was also considered in the HSI calculations. The food and cover conditions in young stands generally go unused because turkeys normally avoid the dense understory conditions found in these stands. Because of this behavioral constraint, stands < 25 years old were assigned an HSI of 0.0 regardless of the food and brood SI's calculated for the stand.

31. Current model variables.

V1 = percent canopy cover of herbaceous vegetation 8 to 24 in. tall

V2 = BA of hard-mast-producing trees ≥ 10 in. dbh

V3 = species diversity of hard-mast producers ≥ 10 in. dbh

V4 = percent of plots with soft-mast producers present

V5 = BA of pines ≥ 10 in. dbh

Suitability index curves for these variables are given in Figure A2.

32. Current life requisites:

Food	$(SIV2 * SIV3)^{1/2} + SIV4 + SIV5$
Brood	SIV1

33. Current HSI determination. The stand HSI will be the greater of the food SI or brood SI values, if the stand age (for forested stands) is > 25 years. If the stand age is ≤ 25 years, the HSI = 0.

Northern bobwhite quail

34. Original model variables. The original set of variables, from Schroeder (1985a)* were:

V1 = percent canopy cover of preferred bobwhite herbaceous plants

V2 = percent of the ground that is bare or covered with a light litter

V3 = type of crop present

V4 = over-winter crop management

V5 = number per acre and average dbh of pine or oak trees ≥ 10 in. dbh

V6 = percent canopy cover of woody vegetation < 2.0 m tall

V8 = average height of herbaceous canopy (summer)

V9 = proportion of herbaceous canopy cover that is grass

V10 = soil moisture regime

35. Original life requisites:

Winter food (grassland/shrubland) $HFSI = \frac{2(SIV1 * SIV2)}{3}$

where, HFSI = herbaceous food suitability index

(croplands) $(HFSI + SIV3) * SIV4$

(forests) $HFSI + \frac{SIV5}{3}$

Cover $(SIV7*SIV8*SIV9)^{1/2} * SIV10$

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* See References at the end of the main text.

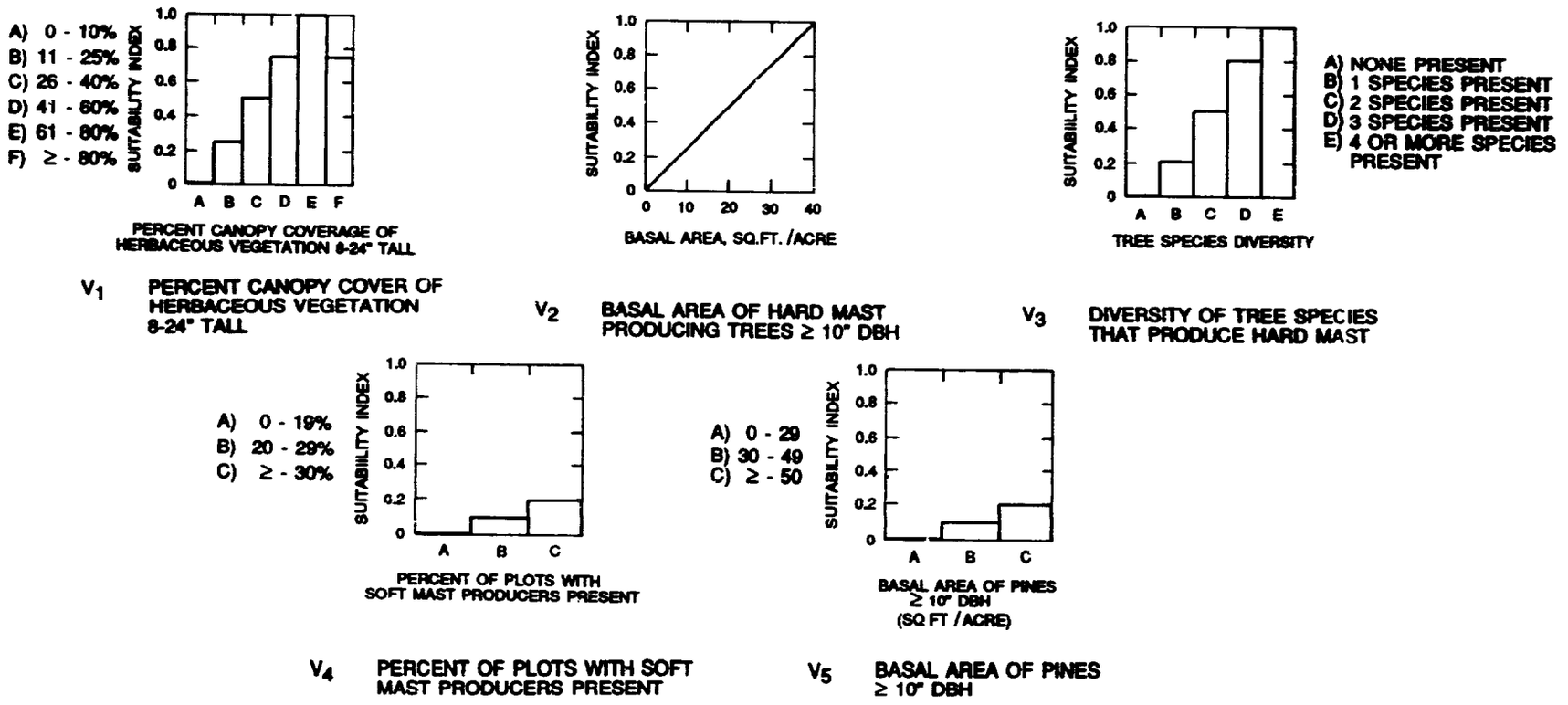


Figure A2. Suitability index curves for the eastern wild turkey HSI model used in the LANDMENU Program for Fort Benning, GA

36. Original HSI determination. Life requisite values for winter food, nesting, and cover are calculated for each major cover type (i.e., forests, shrublands, and croplands) in the study area. These life requisite values are weighted based on the relative percent area in each cover type and the degree of interspersion of cover types; these weighted values are then summed. An SI value for each weighted life requisite is calculated using the SI curves for variables 11-13. The HSI will equal the lowest of these SI values for variables 11-13.

37. Comments. The northern bobwhite quail model has undergone a significant revision from 14 to 4 variables. Also, the procedure for calculating life requisites and HSI values has been changed. The rationale used in this process is explained below.

a. V1. This variable was used without change.

b. V2, V7, V8, V9. The variables that assessed the suitability of a site for nesting were deleted and replaced with a modifier variable (V3). It was considered that nesting cover would not be limiting at Fort Benning due to the extensive forestry and prescribed burning programs in practice, both of which encourage good nesting areas over virtually the entire installation. The procedure used in the current model was based on visual estimates and noted specific areas without suitable nesting cover, thus requiring less intensive sampling than the original model.

c. V3 and V4. These variables were deleted as there is no cropland at Fort Benning.

d. V5. This variable was changed to BA (the current V2).

e. V6. This variable, designed to determine the adequacy of escape cover in the original model, was reformatted and now functions as a modifier (V4) to the HSI. Since almost all of the installation is forested, it was considered that cover should be readily available and consequently not a limiting factor for quail at Fort Benning. The current V4 can be determined without time-consuming measurements and will readily identify any sites where a lack of cover exists.

f. V10: This variable was deleted. This concept is addressed in the management recommendations presented in the main report.

g. V11, V12, V13, V14. These variables were not used since the HSI was calculated in a different manner.

38. Winter food. The rationale for the equation used in determining this life requisite was:

a. Oak and/or pine mast (i.e., 2 * SIV2) could contribute a maximum "raw" HSI of 0.50 in the complete absence of preferred bobwhite herbaceous food plants.

b. Herbaceous foods (i.e., 3 * SIV2) could contribute a maximum "raw" HSI of 0.75 in the complete absence of pine seeds and hard mast.

c. A maximum "raw" HSI value of 1.0 would only be possible with some favorable combination of both food sources.

39. Current model variables.

a. V1 = percent canopy cover of preferred bobwhite herbaceous food plants

b. V2 = BA of pine and/or oak trees ≥ 10 in. dbh

c. V3 = percent of plots with grassy areas suitable for nesting (i.e., having clumps of dead grass 10-30 in. tall)

d. V4 = percent of plots with suitable escape cover

Suitability index curves for these variables are given in Figure A3.

40. Current life requisites.

Winter food	$\frac{(3 * SIV1) + (2 * SIV2)}{4}$
Nesting	SIV3
Cover	SIV4

41. Current HSI determination

Stand HSI = winter food life requisite + (SIV3 + SIV4)

White-tailed deer

42. Original model variables. The original set of variables, from Whelan (1983)* were:

a. V1 = oven-dry weight of natural vegetation known to be important deer forage from October through March

b. V2 = soil phosphorus concentration in parts per million

c. V3 = total BA of all oak trees ≥ 10 in. dbh

d. V4 = number of oak species per unit of sampling area

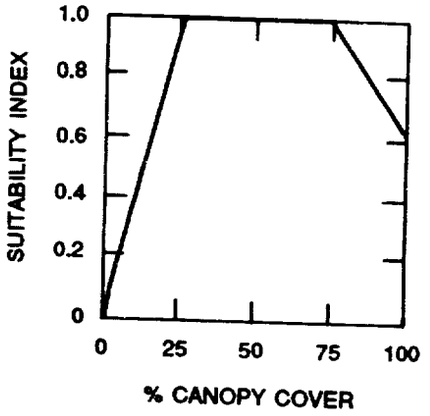
e. V5 = oven-dry weight of crops growing during October through March that are consumed by deer when available

f. V6 = average distance from agricultural land having deer forage potential to shrubland

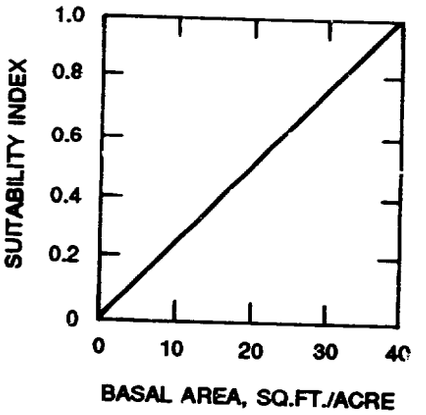
43. Original life requisites.

Winter food	(forests and shrublands)	$\frac{3 * ((SIV1*SIV2) + (SIV3+SIV4)^{1/2})}{4}$
	(croplands)	(SIV5 * SIV6)

* See References at the end of the main text.

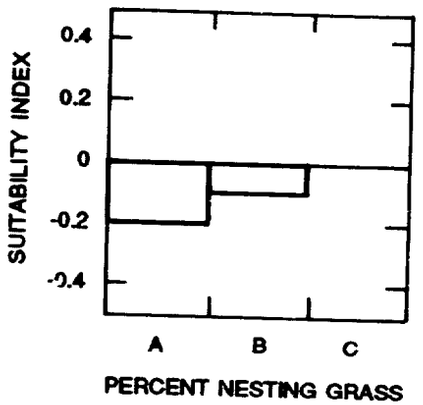


V_1 PERCENT CANOPY COVER OF PREFERRED BOBWHITE HERBACEOUS FOOD PLANTS

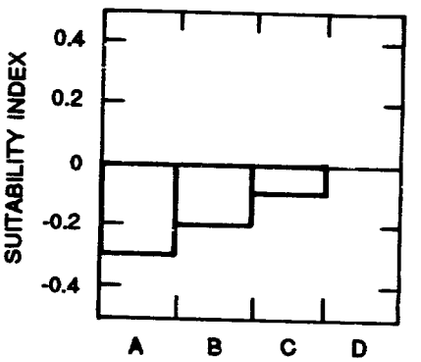


V_2 BASAL AREA OF PINE AND/OR OAK TREES ≥" DBH

A) 0%
B) 1-9%
C) ≥ 10%



V_3 PERCENT OF PLOTS WITH GRASSY AREAS SUITABLE FOR NESTING



A) 0%
B) 1-9%
C) 10-19%
D) ≥ 20%

V_4 PERCENT OF PLOTS WITH SUITABLE ESCAPE COVER

Figure A3. Suitability index curves for the bobwhite quail HSI model used in the LANDMENU Program for Fort Benning, GA

44. Original HSI determination. The values calculated for winter food in forests/shrublands and croplands are weighted by the percentages of the study area in the respective cover types. These weighted values are then summed to obtain an overall HSI score.

45. Comments. The white-tailed deer HSI model has been changed significantly by dropping from six variables to three.

a. VI: This variable was modified from measurements of the weight of deer forage to estimates of cover of the same plants. This was done to eliminate the extreme effort required by clip-and-weigh sampling.

b. V2: The measurement of soil phosphorus concentration was deleted because of the considerable effort and expense required to measure this. This factor was considered beyond the control of the land manager and it was felt that the plant communities themselves would be directly reflective of soil characteristics.

c. V3 and V4: These variables from the original model were essentially unchanged in the current model.

d. V5 and V6: These variables were deleted from the current model as there is no cropland at Fort Benning.

46. Current model variables.

a. V1 = percent canopy cover of natural winter deer forage

b. V2 = BA of oaks $\geq$ 10 in. dbh

c. V3 = species diversity of oaks

Suitability index curves for these variables are given in Figure A4.

47. Current life requisites.

Winter food $$\frac{(3 * SIV1) + ((SIV2 * SIV3)^{1/2})}{4}$$

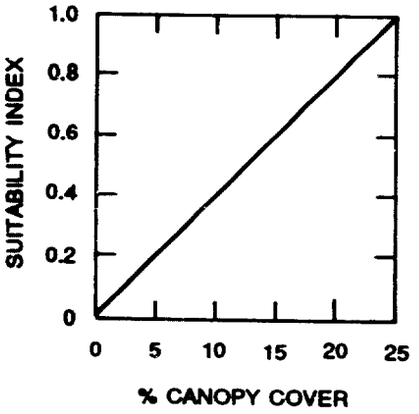
48. Current HSI determination. The HSI equals the winter food life requisite score.

Red-cockaded woodpecker.

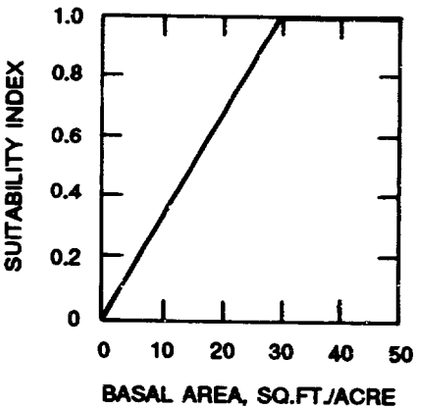
49. Original model variables. There was no HSI model available at the start of this project.

50. Comments. This model, in its current form, emphasizes the factors known to be key features of red-cockaded woodpecker habitat.

a. V1: Stand age is important as a reflection of the relative value of the pine trees present as potential sources of cavities. The older pines are more likely to have red heart disease and thus be suitable as cavity trees. Only stands predominantly composed of acceptable pine species (i.e., all except sand, spruce, white, and table mountain pines) are

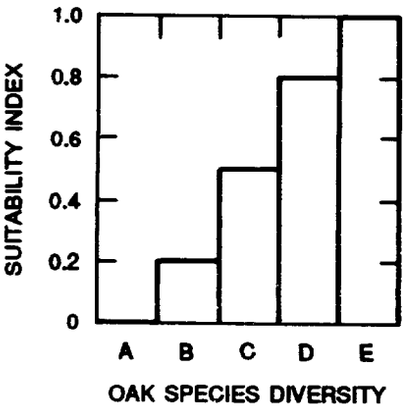


V_1 PERCENT CANOPY COVER OF NATURAL WINTER DEER FORAGE



V_2 BASAL AREA OF OAKS ≥ 10" DBH

A) NONE PRESENT
B) 1 SPECIES PRESENT
C) 2 SPECIES PRESENT
D) 3 SPECIES PRESENT
E) 4 OR MORE SPECIES PRESENT



V_3 SPECIES DIVERSITY OF OAKS

Figure A4. Suitability index curves for the white-tailed deer HSI model used in the LANDMENU Program for Fort Benning, GA

considered in these calculations. All other stands of unacceptable forest types are automatically given HSI's of 0.

The SI curves for Vi have a "flat" portion and a "steep" portion. The steep portion comes from a curve developed by Dr. T. H. Roberts and Ms L. J. O'Neil at WES, with the small change introduced by J. W. Teaford that reflects the assumption that trees 70 and 80 years old (loblolly and longleaf respectively) have an SI value of 0.2 instead of 0.0.

The flat portion of these curves was developed by Teaford based on the following rationale:

(1) The assumption was made that stands 50-60 years old would have a minimum positive value as potential RCW nesting habitat. This is biologically possible as Jackson, Lennartz, and Hooper* (1979) "occasionally" found RCW cavities in trees as young as 30-40 years. This assumption applies primarily to true even-aged stands.

(2) The nature of the stands delineated at Fort Benning was somewhat varied. The stand age is an average value in most cases and an individual stand may encompass a wide variety of age classes, especially in small clumps scattered throughout the stand. This "clumpiness" probably resulted from past cutting practices and from the need for field crews to group similar clumps into manageable stands based on average conditions.

(3) More information on the overall RCW habitat situation was retained by attributing a small value to the younger "potential" stands. The use of a sliding scale of value instead of a discrete threshold better reflected the true current utility/potential utility of the various stands in these age classes just under the threshhold.

b. This variable reflects the feeling that pine stands with BA's from 40-80 sq ft/acre represent optimum conditions for RCW colony sites. Stands significantly sparser or denser than these optimum values have less desirable habitat conditions.

c. As the basal area of hardwoods increases in the colony sites, they become less attractive to RCW's.

d. This variable is the same as VI, but it has a different SI curve which reflects the value of a pine or pine-hardwood stand as potential foraging habitat rather than roosting/nesting habitat.

e. This variable represents the relative impact of hardwoods on the tree composition of the stand. This is similar tc V3, but its SI curve is not as restrictive because RCW's can apparently tolerate more hardwoods in their foraging habitat than they can in their reproductive habitat.

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* See References at the end of the main text.

f. This variable incorporates the concept of large pines (≥ 10 in. dbh) as preferred foraging substrates for RCW's (USFWS 1985). Given the figure of 24 trees per acre ≥ 10 in. dbh as a characteristic of preferred foraging habitat (USFWS 1985)*, this translates to an approximate BA of 13 sq ft/acre for these larger trees. The assumption was made that acceptable habitat would range from a minimum of one third of the preferred level (i.e., eight 10-in. trees or 4 sq ft BA/acre) to three times the preferred level (i.e., 72 trees or 40 sq ft/acre).

51. Current model variables. The model used at Fort Benning was developed by WES personnel. Dr. T. H. Roberts and Ms. L. J. O'Neil formulated the initial version based on draft information and suggestions provided by Dr. M. R. Lennartz of the USFS. Mr. J. W. Teaford later made relatively minor modifications to produce the current version.

a. V1 = stand age (pine and pine-hardwood stands only)

b. V2 = BA of pines (all size classes)

c. V3 = BA of hardwoods (all size classes)

d. V4 = stand age (pine and pine-hardwood stands only)

e. V5 = percent of the total stand BA composed of hardwoods ≥ 10 in. dbh

f. V6 = BA of pines ≥ 10 in. dbh

Suitability index curves for these variables are given in Figure A5.

52. Current life requisites.

Reproduction	$((2*SIV1) * (SIV2 * SIV3))^{1/3}$
Foraging	$(SIV4 * SIV5 * SIV6)^{1/3}$

53. Current HSI determination. The reproductive life requisite is the more limiting factor and should override the foraging component in an HSI determination. However, as this is a sensitive species, both of these life requisite scores are reported with the same status as HSI's.

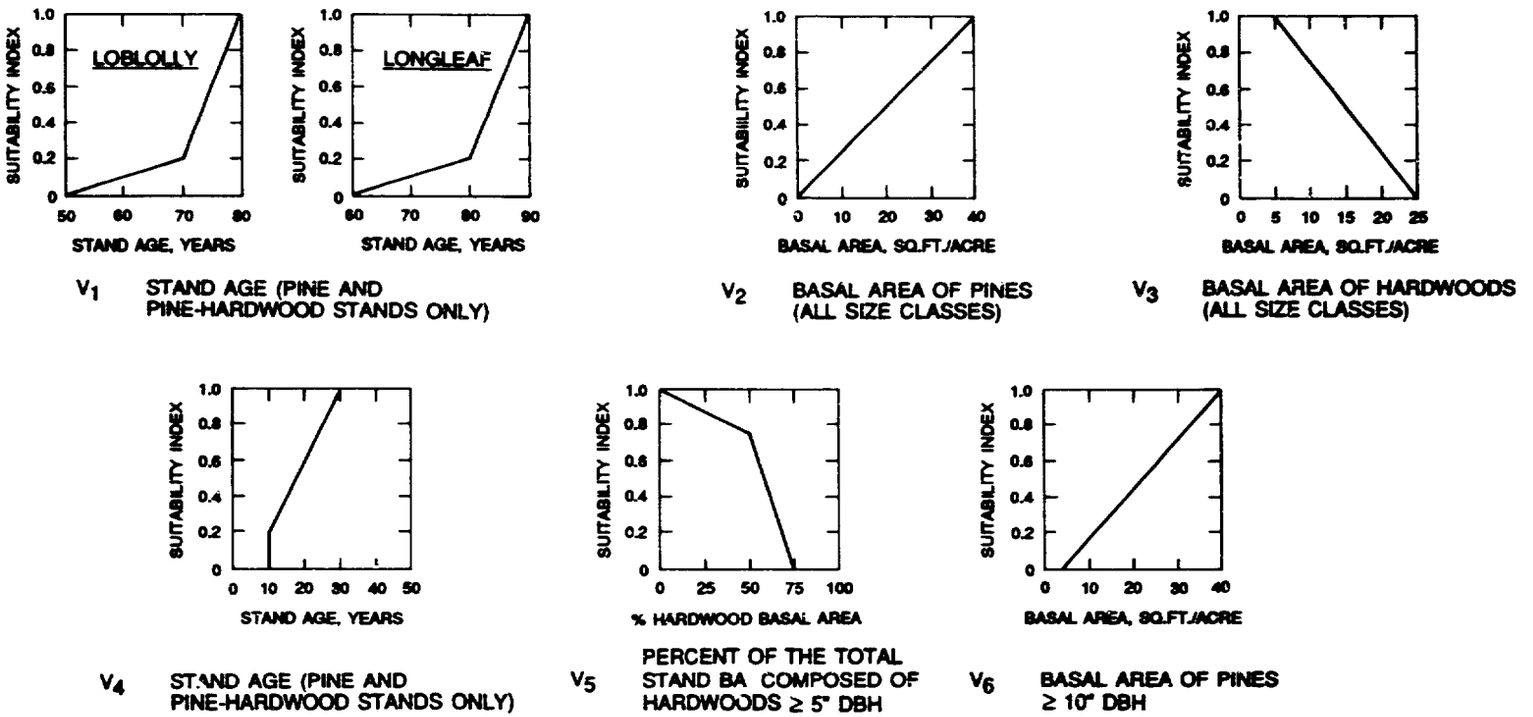

Figure A5. Suitability index curves for the red-cockaded woodpecker HSI model used in the LANDMENU Program for Fort Benning, GA

APPENDIX B: LAND-USE ALLOCATION INSTRUCTION BOOK

APPENDIX B: LAND-USE ALLOCATION INSTRUCTION BOOK

PART I: INTRODUCTION

1. A methodology for applying geographic information system (GIS) techniques to natural and military resource allocations is presented in this workbook. It was developed and tested using only the northwest and southeast sections of the installation; the examples of file names and allocations are presented for the northwest section. Although allocation of all installation lands among the many competing uses was not attempted, the methods could be expanded to accomplish such an objective.

2. This introductory section provides the concepts and premises used to develop the prototype allocation process. It also contains a brief outline of the major steps in the methodology; each step is further outlined in the respective section to provide the reader with a broad overview of the process.

Major Premises

3. There are four fundamental points for understanding and using this methodology:

a. The complete procedure is meant to be generic in application, regarding both the GIS used and the installation location. Although this study used an Earth Resources Data Analysis System (ERDAS) GIS and focused on natural and military resources of Fort Benning, there should be few limitations to operating other GIS's and to applying this methodology to other themes in a military installation.

b. One of the major objectives of the study was to develop a prototype allocation methodology; therefore, liberties have been taken with some data concerning interpretations or classifications. The goal was not to make definitive allocations for Fort Benning, but to present a standardized method for use by on-site personnel. For example, while hardwoods are commercially attractive in parts of the southeastern United States, they were classed as commercially unattractive to maintain a dichotomy of forest resource classifications for developing the methodology. Also, the size of the protective buffer zones around the archaeological and historical sites (as well as around red-cockaded woodpecker [RCW] and gopher tortoise [GT] sites) could be debated. In effect, knowledgeable resource managers may question the specifics of the data interpretations, classifications, and applications, but the major points for utility in a GIS methodology should remain sound.

c. This methodology can be applied most effectively by managers who have basic familiarity with GIS principles. Fundamental GIS operations are assumed to be understood; e.g., overlay of two data layers, creation of buffer zones, etc. Further, because these procedures were developed for an ERDAS-equipped installation, the actual ERDAS commands are not explained in detail; these can be found in the ERDAS manual. However, the essential commands are highlighted for each reference to the manual.

d. Recode and overlay operations were used to construct integrated parametric maps (i.e., integration of various mapped attributes, such as forest stands, soil types, etc.) to show spatial relationships of combined data, either for inventory compilation or for analysis. Generally, where hierarchies of data are designated, the highest numerical value denotes the highest quality or intensity. Both basic inventory maps and parametric maps created from GIS operations (e.g., from overlays) can serve as primary data for subsequent overlays. Integrated parametric maps are often better management tools than a series of single-theme inventory maps or files, since spatial relationships may be perceived with relative ease and accompanying statistics offer detailed analytical data. In some cases, data may have to be generalized, i.e., collapsed into fewer categories than originally delineated, in order to interpret the information more easily. Questions pertaining to detail can be referred to original inventory data, initial maps, support maps, or other statistical data.

Working Concepts

4. Five working concepts are used in applying this methodology:

a. Multiple use. The most efficient use of lands is made when more than one activity can be employed. "Maximization" (also called "optimization") connotes the maximum number of uses assigned to a compartment while maintaining environmental quality and ensuring that the military mission of the installation is not compromised. The methodology is intended to allocate multiple uses to compartments in such a manner.

b. Spatial and thematic balance. Land managers may need to balance activities in each compartment, region, and over the entire installation. Land managers avoid assigning most compartments with one activity that conflicts with others (however suitable the compartment) by recognizing that the need for balance governs a comprehensive allocation process. Also, it is not desirable to focus a set of activities in one part of the installation exclusively, despite a favorable environment; spreading the allocation may be more advantageous and will ensure better integration of uses.

c. Primary and secondary allocations. As will be discussed under the conflict resolution section, a short hierarchy of

allocation importance for each compartment was used to guide the balance mentioned above. By using primary or secondary assignments initially, it was easier to manipulate and understand the possible combinations--by having dominant uses, secondary uses could be considered in a more meaningful manner. Retaining the primary-secondary division in the final steps is not essential.

d. Conflict resolution. Inevitably, after the first attempts at allocation, there will be uses in each compartment that do not easily coexist. This is particularly true after initial military assignments have been made. A relatively simple procedure to resolve conflicts, while maintaining the previous three working concepts, was devised and is presented in the latter stages of this report. NOTE: The entire process involves some form of conflict resolution, even in the preliminary natural resource and military allocation phases. However, only the final allocation steps, where military needs are balanced against natural resource needs, are called conflict resolution.

e. GIS is only a tool. It must be realized that GIS is only a computerized tool that is used by resource managers to facilitate decisions; the GIS does not remove the burden of decision from the manager, but only aids in data management. Ultimately, the manager must make the allocations. This is evident in the steps after inventory and manipulation maps have been made, where the manager scans the maps and accompanying data and subjectively decides which uses should be assigned initially. This point is re-emphasized in the Summary Report.

Problems, Options, and Alternatives

5. Field data were collected at timber stand resolution, which is usually smaller in size than the standard range compartment. However, the military uses the training compartment for decision making, which introduces problems of data reduction. Some environmental factors at Fort Benning can be generalized to the compartment level without loss of significant areal value, e.g., elevation, but most meaningful measures have diverse values throughout the compartment and cannot be reasonably reduced to a single credible composite. For example, the range of timber ages is usually very wide and creation of some index to represent the compartment would be too artificial to be meaningful (a statistical mean with a very wide deviation), forcing data into a misleading datum. This introduces problems in developing useful environmental assessments and preparing for allocation decisions. Attempts were made to resolve apparent discrepancies in stand data in compartment-level generalizations.

6. Various alternative analytical schemes were developed during the course of this study. Most of these are valid and show promise for specific applications, but some schemes may be largely unsatisfactory for the desired project-wide end results. For example, a set of matrices for stand-to-compartment generalization of data (statistical proportion and weighting) was tried and found to be sound in approach but was inappropriate for the type of existing data and for making allocations. Ultimately, subjective judgments were used for assigning compartment ratings, from which regional compilations of assignments could be made. In practice, the analyst scans the compartment and area to determine the best individual item or set of items of a certain category for representation.

7. Instead of using established procedures, another option is to employ alternative data. Although soil factors are indirectly included in site indexes, the user may want to incorporate them directly. Other possible data sets to insert could be: slope, land use, land cover determined from analysis of data collected by the LANDSAT satellite (in place of vegetation and/or forest types), wildlife habitats, hydrology, watersheds, elevations, etc. Once alternative data sets are selected, it is a relatively simple matter to insert them into the methodology and to effectively recode to conform to the flow of operations.

8. Phase I: Preliminary natural resource allocations.
   a. Perform regionalization and compartment masking tasks.
   b. Construct preliminary working files:
      (1) Sensitive sites
      (2) Commercial forestry
      (3) Wildlife habitat suitability indexes (HSI's)
   c. Determine primary and secondary allocations.
9. Phase II: Preliminary military allocations.
   a. Construct special military inventory maps.
   b. Determine suitability guidelines.
   c. Assign preliminary military allocations.
10. Phase III: Conflict resolution.
   a. Construct and compare cross-compatibility matrix and preliminary allocations for incompatibilities.
   b. Determine specialized compartments.
   c. Perform the conflict resolution process.

PART III: PHASE I, PRELIMINARY RESOURCE ALLOCATIONS

Introduction

Overview

11. The allocation process is started with preliminary natural resource allocations made from inventory maps and integrated parametric maps (new maps created by GIS operations). "Sensitive" features and sites, such as endangered or threatened wildlife and archaeological/historical areas, receive the primary focus or priority. Commercial forest management receives second priority, and wildlife habitat third priority. This phase is very important in the allocation methodology and consumes the majority of the time. NOTE: Military requirements are treated separately in Phase II.

12. Phase I steps. The following steps are included in Phase I of the allocation process.

a. Regionalization and compartment masking. Reducing the spatial data set to manageable areas and creating a "cookie-cutter" mask to delineate each specified region.

b. Preliminary working file construction.

(1) Sensitive site maps. Construction of maps of biologically and culturally sensitive areas, including buffer zones around the areas, for:

- o Red-cockaded woodpecker colonies
- o Archaeological sites
- o Gopher tortoise habitat
- o Historical sites

(2) Commercial timber maps. Construction of maps to make commercial timber allocations, based on forest type, stand age, and site index for loblolly pine, mixed pine, and mixed pine and hardwoods.

(3) Wildlife habitat maps. Application of HSI's to evaluate land for wildlife. Major species evaluated: grey squirrel, bobwhite quail, white-tailed deer, eastern wild turkey, RCW reproductive habitat, and RCW foraging habitat.

Integrated parametric maps are created to show combinations of high-value HSI's for various species and selected environmental or resource themes.

Perform preliminary allocation of primary and secondary uses for a compartment.

13. The primary ERDAS routines used in Phase I are as follows:

a. STITCH.

b. RECODE.

c. OVERLAY.

d. MATRIX.

e. SEARCH.

f. INDEX.

Regionalization and Compartment Masking

14. Although ERDAS can handle almost any size region, the monitor display effectively limits the resolution. For example, at 10 m for each cell, any view larger than 512 m in width or height on a 512-m by 512-m monitor will not include all available information. There is too much detail in the Fort Benning data base to display at one time. Also, the natural resources manager cannot easily manipulate and analyze detailed installation-wide resource data for generating maps and GIS coverages for the allocation process. Therefore, Fort Benning is divided into five manageable work units termed "regions" --sections of the fort composed of the aggregation of numerous training compartments.

15. Digitally, each region is defined by constructing a "mask" from which data files will be spatially outlined. Two methods of constructing a mask are possible, depending on the scale of the original data. It is noted that if the desired spatial unit of analysis is the single compartment rather than a multi-compartment region, the same process can be used, but with commensurate adjustments.

a. For scales 1:24,000 and smaller (e.g., 1:50,000):

(1) Digitize each region separately, including each compartment as a distinct polygon (to facilitate recoding at the allocation stage).

(2) Stitch the compartments comprising a region into a single map, taking care to edit all slivers, gaps, and other erroneous data.

(3) Recode all compartments to 0 and the area outside to 1 (as in Step A2.

16. The resulting mask will be a region-shaped, 0-coded, transparent "hole" with a code of 1 defining the outside area. Subsequent recodes

normally will be necessary to insure opaqueness of the outside area and proper insertion of overlay features. That is, the zero value allows all codes from a thematic data file to be inserted into the region and the outside area code 1 will be recoded to a value higher than the maximum data code so that a proper opaque regional definition will result. Because of recoding complexities in most of the following procedures, it is recommended that the mask be applied after all resource data manipulations have been completed rather than trying to mask intervening steps. The recoded mask can be applied at any step for visual and statistical clarity, but continuing subsequent recode routines with the mask in place should be avoided due to complications of recoding.

Preliminary Working File Construction

17. Prior to any allocation, a number of preliminary files and maps must be constructed from existing GIS files. This section outlines the basic steps in the construction of these new files, using the northwest region as an example. Most of the new files are constructed by recoding old GIS values to new values. NOTE: Table 1 contains a list of all file names used in this study.

Sensitive sites

18. Sensitive sites (also termed "sensitives") are composed of RCW sites (including colonies), GT habitats, and archaeological and historical sites (confirmed and unconfirmed, registered and unregistered). RCW's are endangered and GT's are potentially threatened. Most of the data are based on field observations.

19. The first step in the allocation process is to protect sensitive sites. Protective buffers increase security and also help to locate point data on maps. Dr. James Hester* recommended a 100-m zone around archaeological and historical sites. A 60-m RCW and GT buffer was derived from "Policy and Management Guidelines for Red-Cockaded Woodpeckers on Army Installations"** and from Hooper, Robinson, and Jackson (1980).†

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* Personal communication, 1987, James Hester, Archaeologist, IPA from University of Colorado, Boulder, CO.

** Policy letter/directive, 25 Oct 1984, E. T. Wattling, Chief, Facilities Engineering Division, Office, Assistant Chief of Engineers, OCE, Washington, DC.

† See References at the end of the main text.

20. Considerations. Point data are best delineated and surveyed at compartment scale, but most of the maps that are generated later in this process should be produced at the regional level, e.g., northwest section. This is recommended primarily to facilitate completion of mapping and also to achieve the regional view for better synthesis of allocations. Regional displays can be enlarged on the screen for detailed assessment.

21. Until compartment masks are overlaid, typically after several operations, regional definition will not be evident. That is, routines such as Search operate on the entire screen, including the area outside of the gridded coordinate region (normally coded 0). This results in a full-screen coding that can be spatially reconfigured by overlaying a properly coded mask. Therefore, some of the preparatory maps may not be useful in the format designated below, but they can be rendered into a regionally delineated map by overlaying the mask at any stage.

22. Construction detail.

a. Updated RCW field data and RCW/GT locations from the original endangered species are overlaid and recoded to create a new file called NWENDSP (NorthWest ENDangered SPecies).

	Original Code	New Code (NWENDSP)	Interpretation
ESP:	1-4	0	0 = Background
	5	3	1 = RCW unconfirmed
	6	4	2 = RCW confirmed
	7	5	3 = GT unconfirmed
	8	5	4 = GT confirmed
			5 = Outside area
RCW:	1	1	
	2	2	
	3	3	

b. Safety buffers are created for sensitive sites (three separate search operations are involved).

(1) RCW: 60-m search (6 cells @ 10 m/cell) On NWENDSP:
Search from Codes 1 and 2
New file: NWRCWBUF (NorthWest RCW BUFfer)

(2) GT: 60-m (6-cell) search on NWENDSP: Search from codes 3 and 4
New file: NWGTBUF (NorthWest Gopher Tortoise BUFfer)

(3) Arch/historical: 10-m search (10-cell) from NWAH: Search from Codes 1-6
New file: NWAHBUF (NorthWest Archaeological and Historical BUFfer)

(4) Results: The Search routine in ERDAS recodes the central feature(s) to 0 and each concentric zone away from that feature to the corresponding cell distance, e.g., neighboring cell values are based on their distance away from the selected feature, i.e., 1 cell distance = Code 1. The remaining screen (not just mapped area) is recoded to the next higher value, e.g., in a 6-cell search, the multicolor buffer will have a background of Code 7. Thus, the new interpretation is:

0 = Selected feature(s)
1 = First zone (10 m) from selected feature
2 = Second zone (20 m) from selected feature
.....
6 = Sixth zone (670 m) from selected feature
7 = Background

c. Sensitivity site map. Overlay and recode NWRCWBUF, NWGTBUF, AND NWAHBUF to create a new file called NWSEN (NorthWest SENsitive sites). Because all of the buffer is a single protective zone, the search zone codes should be recoded to one exclusive code, corresponding to its theme (i.e., RCW, GT, or Arch/Hist), and the background should be recoded to transparency (0) to allow overlay of other maps or the inclusion of additional features. Each theme is recoded separately into values listed below and then overlaid with each of the other sensitive themes to form a single map of sensitives. Because RCW's are endangered, they are given the highest value, with the buffer zones recoded to a single area of value 3. GT sites are recoded to Code 2 and archaeological and historical sites are given Code 1.

	Original Code	New Code (NWENDSP)	Interpretation
NWRCWBUF	1-6	3	RCW buffer zones
	7	0	Background
NWGTBUF	1-6	2	GT buffer zones
	7	0	Background
NWAHBUF	1-10	1	Arch/Hist zones
	11	0	Background

NOTE: A compartment mask could be overlaid onto NWSEN to make a sensitivity inventory map.

Commercial timber

23. Timber allocation uses forest types, stand age, site index, and combination overlays. Allocations are made by assessing the type of forest cover in each compartment, its distribution, site index, and the nature and magnitude of peripheral features such as sensitive sites.

24. Forest types. Loblolly pines are the most attractive for commercial forest management, followed by mixed pines, then mixed pine and hardwoods. Although there are some marketable hardwoods at Fort Benning, they are not considered commercially valuable for the purpose of this allocation prototype.

25. In the field inventory survey data, individual stands were identified by forest type, age, condition class, etc. These stands were digitized by stand number and are found in the file NWTBR (NorthWest TimBeR). Forest type codes from the US Forest Service Southern Region Compartment Prescription Handbook (1977) were given a GIS code that was then used to recode the stand numbers to forest type in the new file NWTBRFT (NorthWest TimBeR Forest Type).

Type Code		New TBRFT GIS Code
21	Longleaf pine	1
22	Slash pine	2
25	Mixed pine	3
31	Loblolly pine	4
31P	Loblolly pine plantation	5
32	Shortleaf pine	6
10	Yellow pine/upland hardwood	7
13	Loblolly pine/hardwood	8
42	Upland hardwood/yellow pine	9
44	Southern red oak/yellow pine	10
46	Bottomland hardwood/yellow pine	11
49	Bear oak/southern scrub oaks/ yellow pine	12
53	White oak/red oak/hickory	13
54	White oak	14
56	Yellow poplar/white oak/ laurel or willow or water oak	15
57	Scrub oak	16
58	Sweet gum/yellow poplar	17
62	Sweet gum/water oak/willow oak	18
64	Laurel oak/willow oak	19
68	Sweetbay/swamp tupelo/red maple	20
63	Sugarberry/American elm/green ash	21
22P	Slash pine plantation	22
69	Beech/magnolia	23
70A	Wildlife opening (stand)	24
70B	Wildlife opening (inclusion)	25
96	Pine inclusion	26
97	Hardwood inclusion	27
98	Undrained flatwoods	28
99	Brush species	29
90	Military site	30
100-140	Water area	31
21P	Longleaf pine plantation	32
25P	Mixed pine plantation	33

	Type Code	New TBRFT GIS Code
*	Other, non-forested	34
41	Core hardwoods/yellow pine	35
9	Yellow pine/core hardwoods	36
**	Other, forested	37
60	Sweetgum	38
83	Red mulberry	39
80	Black gum	40
48	Southern red oak/hickory/ yellow pine	41
12	Shortleaf pine/oak	42
71	Black ash/American elm/red maple	43
30	Spruce pine/hardwood	44
40	Hardwood/pond pine	45
	Pine/hardwood inclusion	46
	Hardwood/pine inclusion	47
51	Post oak/black oak	48
55	Southern red oak	49
18	Pond pine/hardwood	50
72	River birch/sycamore	51

* Includes:	240	Special use other than military
	400-440	Scenic/historical/archaeological area
	510	Key area for featured wildlife species
	610	Special timber management area
	710-770	If not forest land
	801	Developed recreation sites on non-forest land
		Non-stocked inclusions
		Inoperable inclusions on non-forest land

** Includes:	240	If it is special-use forest land
	700-770	If forest land
	801	Developed recreation sites on forest land
	900	Forest land below productivity standards
		Inoperable forest land land
		Southern pine beetle (SPB) infested area

26. Timber age. Field data for stand ages are first converted to a standard GIS code and then recoded in the NWTBR file to create the new file NWTBRAG (NorthWest TimBeR AGes).

Stand Age (Field Data)	GIS Code (NWTBRAG)
0-10	1
11-20	2

Stand Age (Field Data)	GIS Code (NWTBRAG)
21-30	3
31-40	4
41-50	5
51-60	6
61-70	7
71-80	8
81-90	9
91-100	10
101-150	11
151+	12
Other	13

27. The age of a timber stand is meaningful in evaluating commercial value and management needs, e.g., very young (potentially fragile) stands are not immediately available for commercial harvest and many also require certain protective practices. For this study, 0- to 10-year-old stands were considered as fragile--not conducive for supporting heavy training activities. Conversely, these areas possess possible utility for vehicle training, provided severe damage is acceptable at select sites. Ages 11-15 are not considered fragile, but are still too young for thinning or harvesting). Generally, at ages 15-30 most Southeast pine forests are best-suited for pulpwood. Pines between 30 and 60 years old are regarded as mature poletimber to immature sawtimber. Pine stands over 60 years old are mature, ready for harvesting, and therefore are classed as mature sawtimber. NOTE: The entire age class of 11-20 will be considered for pulpwood production in later steps. These relationships were based on past experience of field personnel.

28. Site index. Site index (SI) is a single composite measure for several ecological factors that determine the vigor and growth rate of trees. Specifically, SI is the height a tree will grow in a specified period of time (50 years in the Southeast). Categories of poor, moderate, high, and very high were used to indicate the potential for commercial forest management. The process first required conversion of field data to standard GIS codes. These codes were then recoded in NWTBR to create a new file called NWTBRSI (NorthWest TimBeR Site Index) showing the actual site index for each stand.

Site Index (Field Data)	GIS Code (NWTBRSI)
<30 (<34)	1
40 (35-44)	2
50 (45-54)	3

Site Index (Field Data)	GIS Code (NWTBRSI)
60 (55-64)	4
70 (65-74)	5
80 (75-84)	6
90 (85-94)	7
0 (95-104)	8
110 (105-114)	9
120 (115-124)	10
130 (125-134)	11
140 (135+)	12
Other vegetation*	13
Other non-vegetation**	14

* Includes RCW's, wildlife plots, hardwood inclusions, pine inclusions, brush species, inoperable inclusions, undrained flatwoods, and young plantations.

** Includes military sites, roads, water, non-stocked sites, and other non-forest.

29. These actual SI values were then collapsed into the five interpretive categories and the file was recoded to produce the new file NWRECSI (NorthWest RECoded Site Index).

NWTBRSI GIS Code	Interpretive Recode (NWRECSI)	Interpretation
1-3	2	Poor; SI = <70
4	3	Moderate; SI = 70-79
5-6	4	High; SI = 80-89
7-12	5	Very high; SI = 90+
13-14	1	Not applicable (N/A)

NOTE: These SI values are used solely for demonstrating the allocation process. Recommended SI values, based on actual Fort Benning conditions are: poor (<70), moderate (70-79), high (80-89), and very high (90+).

30. Since some high SI areas may not be amenable to commercial forestry due to presence of sensitive sites, one last step is necessary. NWRECSI is combined (overlaid) with NWSEN to produce the new file NWSISEN (NorthWest Site Index and SENsitives).

Original File Names	Original GIS Codes	New GIS Codes (NWSISEN)
NWRECSI	1	No recode
	2	" "
	3	" "

Original File Names	Original GIS Codes	New GIS Codes (NWSISEN)
	4	" "
	5	" "
NWSEN	1	6
	2	7
	3	8

Interpretation: 1-5 = Site index classes from NWRECSI
6 = Arch-historical sites
7 = GT sites
8 = RCW sites

31. Initial working allocations for timber. Initial timber allocations can now be made by combining forest types, NWSISEN data, and stand age. However, because of the many possible combinations of attribute pairing, a matrix operation must be used, thereby limiting input files to two (see the ERDAS manual for a complete explanation of the matrix operation). The first pairing is comprised of NWSISEN and recoded forest types using NWTBRFT. To construct the matrix, the NWTBRFT file is recoded from 51 values into 5 values with an interim interpretation as follows. (NOTE: These interim recodes are also found in the file NWCOMFT = NorthWest COMmercial Forest Types.)

Matrix: NWTBRFT and NWSISEN
Matrix size: 5 columns x 8 rows

NWTBRFT Code	New Code for Matrix columns	Interim Interpretation
1-3	4	1 = Other; no commercial value
4-5	5	2 = Hardwoods
6	4	3 = Mixed pine and hardwoods
7-11	3	4 = All other pines
12-21	2	5 = Loblolly pines
22	4	
23	2	
24-25	1	
26	4	
27	2	
28-31	1	
32-33	4	
34	1	
35-36	3	
37	1	
38-40	2	
41-42	3	
43	2	

RECODE MATRIX

Columns (GIS File = NWTBREF)

Rows (GIS File = NWSISEN)

	Other - No Commercial Value	Hardwoods	Mixed Pine Hardwoods	All Other Pines	Loblolly Pines	6	7	8
	1	2	3	4	5	6	7	8
1 N/A	1* 1**	1 2	1 3	1 4	1 5	NOT USED		
2 Poor SI <70	1 6	1 7	1 8	1 9	1 10			
3 Moderate SI 70-79	1 11	2 12	2 13	3 14	4 15			
4 High SI 80-89	1 16	2 17	2 18	3 19	4 20			
5 Very High SI 90+	1 21	2 22	2 23	3 24	4 25			
6 Arch/ Hist sites	5 26	5 27	5 28	5 29	5 30			
7 GT sites	6 31	6 32	6 33	6 34	6 35			
8 RCW sites	7 36	7 37	7 38	7 39	7 40			
9	NOT USED →							
10								
11								

* = Output file value

** = Cell number

Figure B1. Example working matrix for recoding GIS files

NWTBRFT Code	New Code for Matrix columns	Interim Interpretation
44-47	3	
48	2	
49	2	
50	3	
51	2	

32. These values are placed on the X-axis of a working matrix (Figure B1) to form the columns. The Y-axis is formed by using the GIS codes from the NWSISEN file without any recode. All cells are numbered from left to right consecutively, starting with the junction of Row 1/Column 1 = Cell 1, thrcugh Row 8/Column 5 = Cell 40.

33. Matrix cell numbers are then recoded to two site index measures of poor (unacceptable) and moderate to very high (merits consideration for commercial timber production) and to three timber types based on increasing commercial value: mixed pines and hardwoods, mixed pine, and loblolly pine. These result in a new file called NWPRETAL (NorthWest PRElliminary Timber ALlocation) as follows:

Matrix Cell Number	New Output File Value (NWPRETAL)
1-11	1
12-13	2
14	3
15	4
16	1
17-18	2
19	3
20	4
21	1
22-23	2
24	3
25	4
26-30	5
31-35	6
36-40	7

Interpretation:
1 = Poor; no value; SI = <70; N/A
2 = Mod-VH mixed pine hardwood; SI = 70+
3 = Mod-VH mix pine; SI = 70+
4 = Mod-VH loblolly; SI = 70+
5 = Arch/hist sites
6 = GT sites
7 = RCW sites

34. The second pairing combines NWPRETAL data with stand age (using a matrix similar to that used for site index) to present a relatively complete survey of the primary components useful for commercial forest management evaluation. Age classes are compressed for product description as discussed in "Timber Age" above. This matrix results in a new file called NWTIMALO (NorthWest TIMber ALlOcation).

Matrix: NWPRETAL and age (TBRAG)
Matrix size: 4 columns x 8 rows

NWTBRAG Code	New Code for Matrix columns	Interim Interpretation
1	1	0-10 years old
2,3	2	11-30 years old
4-6	3	31-60 years old
7-16	4	60+ years old
17	1	Other

35. The rows in this matrix are formed by using the GIS codes from NWPRETAL without any recode. Cell numbers are then recoded as follows:

Matrix Cell Number	New Output File Value (NWTIMALO)
1-4	1
5	2
6	3
7	4
8	5
9	6
10	7
11	8
12	9
13	10
14	11
15	12
16	13
17-20	14
21-24	15
25-28	16

Interpretation

1 = N/A; No Use
2 = Fragile 0-10 yrs; moderate-very high SI for hardwood & pine
3 = Moderate-very high hardwood & pine; 11-30 yrs; pulpwood
4 = Moderate-very high hardwood & pine; 31-60 yrs; immature sawtimber-pulpwood

5 = Moderate-very high hardwood & pine; 60+ yrs; mature sawtimber
6 = Fragile 0-10 yrs; moderate-very high mixed pine
7 = Mixed pine; 11-30 yrs; pulpwood
8 = Mixed pine; 31-60 yrs: immature sawtimber-pulpwood
9 = Mixed pine; 60+ yrs; mature sawtimber
10 = Fragile 0-10 yrs; loblolly
11 = Loblolly 11-30 yrs; pulpwood
12 = Loblolly 31-60 yrs; immature sawtimber-pulpwood
13 = Loblolly 60+ yrs; mature sawtimber
14 = Archaeological-historical sites
15 = Gopher tortoise sites
16 = RCW sites

NOTE: 0-10 yrs old--"Fragile"
11-30 Best for immature pulpwood
31-60 Best for mature pulpwood and immature sawtimber
60+ Best for mature sawtimber

36. TIMALO data provide basic management information, but further recoding can address more specific requirements or tasks. For example, if loblolly pine is assumed to be the most valuable timber resource in the study area, reduction of data to focus on its management is the first practical use made of timber allocation maps. Recode TIMALO maps into six classes of: No-use or fragile timber (0-10 years old), sensitive sites (RCW, archaeological, etc.), moderate site index for hardwoods and pines and for mixed pine classes (11+ years old), moderate site index for loblolly (11-60 years old), and high site index for mature loblolly (60+ years). This produces a new file called NWLOBAL (NorthWest LOBlolly ALlocation).

NWTIMALO GIS Codes	New GIS Codes (NWLOBAL)
1	1
2	2
3	4
4	4
5	4
6	2
7	4
8	4
9	4
10	2
11	5
12	5
13	6
14	3
15	3
16	3

Interpretation

1 = N/A; No use
2 = Fragile (0-10 yrs old)
3 = Sensitives
4 = Moderate site index, hardwoods and pines, mixed pines
5 = Moderate site index, loblolly (11-60 yrs old)
6 = High site index, mature loblolly (60+ yrs old)

37. The same process can be duplicated for any other class of management or timber type.

Wildlife habitats

38. HIS's are used on a compartment basis to show relative potential of that compartment for supporting various wildlife species. Individual HSI values were calculated for gray squirrel, bobwhite quail, white-tailed deer, eastern wild turkey, RCW reproductive habitat, and RCW foraging habitat for each timber stand from field data. These were then consolidated to produce a single HSI for each training compartment for each species. GIS codes from 1 to 5 (poor to excellent HSI) were assigned for each species in the files NWGSQHSI, NWBWQHSI, NWWTDHSI, NWEWTHSI, NWRCRHSI, and NWRCFHSI, respectively.

39. There are various management considerations and applications for HSI data but one of the first uses after initial inventory mapping of each species, is to compare where potential wildlife areas exist in relation to potential commercial timber sites (which in turn will be compared to preliminary military assignments in the final allocation process). The following steps continue the natural resource assessment procedure, with a goal of determining potentially attractive wildlife management areas. NOTE: Because RCW's are endangered and protected by Federal legislation, they are automatically included in any management scheme, regardless of primary allocation and thus are not included in the HSI and timber matrices.

40. Combining the HSI data with TIMALO data shows where high, moderate, and low HSI's for each species occur and identifies the combination. A matrix is constructed in the same manner as for NWPRETAL (Figure B1) for each species, resulting in the files NWTIMGSQ (NorthWest TIMber Allocation and Grey SQuirrel HSI), NWTIMBWQ, NWTIMWTD, MWTIMEWT, MWTIMRCR, AND MWTIMRCF. In this example, only NWTIMGSQ is constructed.

Matrix: NWGSQHSI and TIMALO
Matrix size: 3 columns x 16 rows

NWGSQHSI Code	New Code for Matrix Columns	Interim Interpretation
1-2	1	Low HSI (not useful)
3-4	2	Moderate HSI (possibly attractive)
5	3	High HSI (most attractive)

41. The rows of the matrix are formed by using the 16 GIS codes from the NWTIMALO file without any recode. Cell numbers from the matrix are then recoded as follows:

Matrix Cell Number	New Output File Value (NWTIMGSQ)
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	16
9	25
10	8
11	17
12	26
13	9
14	18
15	27
16	4
17	5
18	6
19	10
20	19
21	28
22	11
23	20
24	29
25	12
26	21
27	30
28	4
29	5
30	6
31	13
32	22
33	31
34	14
35	23
36	32

37	15
38	24
39	33
40-42	34
43-45	35
46-48	36

1 = No use; N/A
2 = Fragile (low HSI)
3 = Moderate HSI & N/A timber
4 = High HSI & N/A timber
5 = Fragiles & moderate HSI
6 = Fragiles & high HSI
7 = Moderate-very high hardwood & pine; pulp; low HSI
8 = Moderate-very high hardwood & pine; sawtimber-pulp; low HSI
9 = Moderate-very high hardwood & pine; mature sawtimber; low HSI
10 = Mixed pine; pulp; low HSI
11 = Mixed pine; sawtimber-pulp; low HSI
12 = Mixed pine; mature sawtimber; low HSI
13 = Loblolly; pulp; low HSI
14 = Loblolly; sawtimber-pulp; low HSI
15 = Loblolly; mature sawtimber; low HSI
16 = Moderate-very high hardwood & pine; pulp; moderate HSI
17 = Moderate-very high hardwood & pine; sawtimber-pulp; moderate HSI
18 = Moderate-very high hardwood & pine; mature sawtimber; moderate HSI
19 = Mixed pine; pulp; moderate HSI
20 = Mixed pine; sawtimber-pulp; moderate HSI
21 = Mixed pine; mature pulp; moderate HSI
22 = Loblolly; pulp; moderate HSI
23 = Loblolly; sawtimber-pulp; moderate HSI
24 = Loblolly; mature sawtimber; moderate HSI
25 = Moderate-very high hardwood & pine; pulp; high HSI
26 = Moderate-very high hardwood & pine; sawtimber-pulp; high HSI
27 = Moderate-very high hardwood & pine; mature sawtimber; high HSI
28 = Mixed pine; pulp; high HSI
29 = Mixed pine; sawtimber-pulp; high HSI
30 = Mixed pine; mature sawtimber; high HSI
31 = Loblolly; pulp; high HSI
32 = Loblolly; sawtimber-pulp; high HSI
33 = Loblolly; mature sawtimber; high HSI
34 = Archaeological/historical sites
35 = Gopher tortoise sites
36 = RCW sites

Additional matrices should be completed for each species, using;

NWBWQHSI--Bobwhite quail
NWWTDHSI--White-tailed deer
NWEWTHSI--Eastern wild turkey

42. The resource manager can select the highest coded compartments of each species and the corresponding timber habitat to evaluate allocations to

either commercial forest products or to wildlife habitat. However, better results can be obtained by overlaying the HSI measures for each species with the preliminary timber allocations for each compartment. ERDAS can manage four overlays in one operation; the index option should be used to achieve either a simple or a more comprehensive analysis.

43. Simple analysis. By coding only the highest HSI measure (5, or 4 and 5, depending on the manager's needs) to 1 and all else to 0, overlay using the addition option in the index mode will result in a value of 4 for coincidence of all four highest HSI's in one compartment, a value of 3 for any three, and so on. Identity within combinations (of two or three elements) is not possible on this scheme, but it does show the general potential for wildlife allocation.

44. Comprehensive analysis. A procedure for identifying any combination of the four HSI files is possible, though a bit cumbersome. The basic technique is to recode the high HSI's in such a manner as to elicit a unique code with any combination. Using any order of the four files (A,B,C, or D), recoded the high HSI values (5, or 4 and 5):

File	Recoded Value for High HSI
A	1
B	5
C	10
D	20

NOTE: All other HSI values in each file are recoded to 0.

Interpretation

0 = No occurrence
1 = A high only
5 = B high only
6 = A and B
10 = C high only
11 = A and C
15 = B and C
16 = A, B, and C
20 = D high only
21 = A and D
25 = B and D
26 = A, B, and D
30 = C and D
31 = A, C, and D

35 = B, C, and D
36 = A, B, C, and D

45. More complex recoding to accommodate two HSI measures for each file could be accomplished, but the number of combinations (64 variables to identify moderate and high HSI's in all four files) make it impractical.

46. From these results, the resource manager can appreciate the potential productivity of each compartment and allocate accordingly. Where high HSI values and attractive timber coincide, the manager must make a subjective decision regarding the proper preliminary allocation.

Soil data and site index

47. Often, soil data provide preferred information. One of the stated measures of US Department of Agriculture (USDA) soil analysis is the "potential site index"--site index that is based on the soil potential, as opposed to the observed or prevailing conditions. Such a measure denotes the potential of the soil, which may be a better indicator of management possibilities than is the site index of current vegetation. Present growth conditions may be an anomaly, and are subject to change as a result of management decisions.

48. Although not used in this particular allocation, soils can be recoded to a particular species' potential site index (from the USDA soil survey) to allow thematic evaluation. For example, by recoding for potential loblolly pine site index, the manager can visualize the possible commercial forest productivity under altered conditions. Further, by comparing that potential site index to observed site index, assessment of maximum or efficient utility of lands can be made. Compartments not under efficient use can be changed accordingly as management schedules are completed. Compartments having different yet equally efficient uses may not be changed during the current cycle of use, but may be considered for conversion at a more appropriate time (e.g., after harvesting).

Primary and Secondary Allocation Process

The decision process

49. While GIS techniques offer sophisticated methods of observing and manipulating data, it is the manager, using a largely subjective process, who makes the actual allocations. Data should be perceived as conveniently

structured information that can be analyzed according to differing demands or influences.

50. Initially, assessment of each compartment's primary value in the multiple-use scheme may be made individually and, although largely subjective, it is judgment based upon objectively mapped data. The allocation terms "primary" and "secondary" have been used to denote the major activity(ies) that could be assigned. The terms may be used either as guides or for organizational convenience rather than as rigid hierarchical assignments. Such a classification helps to ensure a desirable balance of activities. Multiple use does not demand a hierarchy of assignments. However, the manager does need to maintain spatial and functional organization of allocations to ensure that each activity is given sufficient assignment and adequate space. Conversely, that space must be utilized efficiently and in balance with operational objectives. As will be discussed, these concepts can be applied at various scales, from ensuring balance in a single compartment to spatial analysis of regions within the installation.

51. Primary refers to the most important use that could or should be made of a given compartment; it has priority for assignment and usually takes precedence over other activities. Secondary denotes lesser suitability and infers that assignments may be made only if the primary ones are maintained in an acceptable manner, as judged by the resource manager. Conflict between uses will be addressed under conflict resolution in Phase II.

The allocation process

52. Upon completion of map construction and working files, a more comprehensive allocation process begins. Tab 2 presents the decisional chart and accompanying dichotomous key for making initial natural resource allocations. This chart offers a step-by-step procedure, addressing each item in the priority established here, to decide the best one or two primary activities that should be assigned to a compartment. Also, it may help in the integration of secondary assignments. The table is constructed to be as generic as possible; it may be modified according to local conditions and changing managerial objectives.

53. First, the manager examines each compartment, focusing initially on the sensitive sites. If a high concentration of sensitive areas exists, a preference for preservation and conservation of wildlife and/or archaeological/historical resources may prevail. If sensitive sites are few,

the next selection should focus on commercial forest management. Normally loblolly pine will be selected first, followed by mixed pines and then possibly mixed pines and hardwoods. Superimposed upon the resource allocations will be military selections (to be discussed in Phase II). The managerial task is to evaluate the spatial and relational aspects of the various mapped classes and to decide which use(s), if any, should be given primary allocation and which should accompany them as secondary assignments. The idea of multiple use should be kept in mind during all phases.

54. The procedure is flexible and may be adjusted according to the local manager's desires. For example, although the HSI files (e.g., NWGSQHSI) and the HSI/timber files (e.g., NWTIMGSQ) were not used this example, the manager could incorporate similar files in the same manner as shown below for the other files. Throughout the allocation process, numerous other maps were used as support, but the following maps and/or files stand as the essential set that were consulted for the initial allocation.

a. NWCOMFT (general commercial forest types)

b. NWTBRFT (specific forest types)

c. NWSISEN (site index and sensitive sites)

d. NWPRETAL (forest types and site index)

e. NWTIMALO (forest types, site index, age)

f. NWLOBAL (commercial loblolly and sensitive sites)

55. At this point, the process is only one of preliminary allocation; there is little need for anticipation of possible conflicts with military uses. The premise is to make an initial resource allocation and later to assess the military associations. It is possible that premature and unwarranted rejection of some activity could occur if conflicts were anticipated this early.

56. Some features, particularly point data such as RCW trees or colony locations, may exist in clusters or concentrations within part of a compartment. If they are distributed over a large portion of the compartment (densely clustered over multiple parts or evenly distributed throughout with a medium density) a primary allocation should be considered. If sparsely distributed, secondary allocation is on order. Also, there can be clusters of point data that are too small to dominate the compartment's assignment but are sufficiently large to warrant attention and protection. These should be delineated as subcompartment--exclusive areas established to preserve the

point attribute while maintaining a separate primary allocation for the remainder of the compartment. In effect, subcompartments become very small compartments and are managed distinctly. Fundamentally, they normally will not share allocations, because the assignment is unique to that specific area. Hence, there will be no need for conflict resolution considerations (to be discussed).

57. Table B1 shows the result of this first phase. NOTE: This table will also be used in Phase II and therefore contains military allocations. These should be ignored at this time.

Table B1

Preliminary (Initial) Primary and Secondary Allocations for Northwest Region Compartments of Fort Benning, GA Before Resolution of Conflicts

Compartment	Wildlife RCW & GT	Arch/Hist Sites	Special Military Sites	Loblolly Pine	Mixed Pine	Mixed Pine & Hardwood	Unit Vehicle	Unit Foot	Bivouac	Open, No Decision	Possible Subcompt	Total P	Total S
M11		S				P	P	P	P		M	4	1
M12		S			P		S	S	P		AH	2	3
N01	S	S		P			P	P	S		AH	3	3
N02				P			S	P	P			3	1
002						P	S	S	P			2	2
003	P	S			S		S	S	P		RCW & GT	2	4
004	S				P		S	S	P		GT	2	3
005				P	S		P	S	P			3	2
006	S			P	S		P	P	P		GT	4	2
007		S		P		S	S	S	S		AH	1	5
008	S	S			S		S	P	P	P	RCW & GT	3	4
009		S	P				S	S	P			2	3
010	S		P				P	S	P		RCW & GT	3	2
011		S	P				S	S	P			2	3
012					P		S	S	P			2	2
013	S	S			P		S	S	P		RCW & M	2	4
014	S	S		P			P	S	P		RCW	3	3
015	P	S		S			P	S	P		RCW,AH,M	3	3
Total P's	2	0	3	6	4	2	7	5	16	1		46	
Total S's	7	11	0	1	4	1	11	13	2	0			50
Totals	9	11	3	7	8	3	18	18	18	1			96

NOTE: P = Primary allocation
S = Secondary allocation
AH = Archaeological/historical
GT = Gopher tortoise
RCW = Red-cockaded woodpecker
M = Military

PART IV: PHASE II, PRELIMINARY MILITARY ALLOCATIONS

Introduction

Overview

58. Military resource requirements are different in concept and type from environmental resources and therefore require distinct approaches. Whereas most environmental factors are physically linked, i.e., controlled by associated natural processes, military components are not necessarily related by common or similar processes or reasons. Features that exist in one area may have no relation to features of adjacent sites. Because of this lack of functional linkage, military maps must be constructed primarily as basic inventory maps or simple combinations of military features. Additionally, elaborate manipulations that are used to assemble the natural resource data base are not necessary in this phase.

59. Except for some literature on heavy mechanized trafficability standards, information is lacking concerning the environmental requirements for the types of training occurring at Fort Benning. Consequently, selection of environmental criteria for training had to be developed. This phase is based on preliminary results of establishing environmental guidelines for basic military training activities. The scheme matched existing vegetation, relief, roads, stream fords, etc., with typical and probable needs and activities of various training operations. Compartments were assigned primary or secondary training allocations based on these data.

60. Before the environmental requirements scheme was developed in this project, the only alternative to the absence of established guidelines was to analyze Fort Benning historical training data (area assignments) in hopes of discovering useful relationships between compartment environments and the types of training occurring in each. Although the concept seems viable, mixed results were obtained. Historical training data should be used cautiously for primary data or as a basis for establishing environmental guidelines.

61. Phase II steps. The following steps are included in Phase II of the allocation process.

a. Construct special military inventory maps.

b. Develop suitability guidelines.

c. Determine resource suitability and allocations for military training.

(1) Heaving training (vehicle based)

(2) Moderate training (dismounted unit)

(3) Light training (individual and special)

62. The primary ERDAS routines used in Phase II are:

a. RECODE.

b. OVERLAY.

Special Military Maps

63. Military maps show locations of selected features of military importance and environmental properties recoded for military relevance. They contain pertinent features that are needed in the preliminary military allocation process. Each map has data from one or more inventory maps and the data are grouped into convenient military categories. Some diverse but related data are combined into single maps for convenience. A total of 17 base maps were constructed for this phase. All but the erosion hazard map and the slope map are derived from the Fort Benning Terrain Analysis (US Army Engineer Topographic Laboratory 1976)* and are recodes of printed data:

a. NWCAMOF--Concealment from air and ground for foot troops, on a seasonal basis. Recoded from the Mobility Atlas vegetation map.

(1) NWCAMFA--from the air.

(2) NWCAMFG--from the ground.

b. NWCAMOV--Concealment from air and ground for vehicles, on a seasonal basis.

c. NWFTCOV--Cover from flat trajectory of munitions fired by small arms for foot troops, from dense and sparse vegetation.

d. NWTRANS--Roads, tank trails, helipads, airfields, landing zones, bridges, and fords.

e. NWMISRG--Firing points, observation towers, pillboxes, and miscellaneous firing ranges.

f. NWMISC--buildings, bleachers, power substations and lines, various pits, revetments, etc.

g. NWBKSLP--Slope classes of stream banks on major streams, classed according to bank height and slope.

h. NWBKGAP--Bank-to-bank distance on major streams.

i. NWCCM--Cross-country movement--terrain units based mostly on vegetation type and density, including slope.

j. NWCCMSL--Generalized slopes from the cross-country movement file; quality ratings from very gently rolling to very steep.

k. NWBVLIM--Bivouac site limitations, quality ratings. From BVAR soils data.

l. NWEROS--Erosion hazard from Soil Conservation Service (SCS) data. Quality ratings from slight to severe.

m. NWTRGBV--Special military training areas (e.g., AO Yellow) and established bivouac sites. From Fort Benning personnel.

n. NWTFRAG--Fragile timber, sensitive sites, grasslands, marshes, swamps, wildlife openings, special military areas - used for Openlands determination.

o. NWSLPREC--100-m slope information recoded from SLOPE.

64. Of these original 17 files, only NWCAMOF, NWCAMFA, NWCAMFG, NWFTCOV, NWTRANS, NWBKSLP, NWEROS, NWTRGBV, NWTFRAG, and NWSLP are used in the allocation process. The actual construction of each of these maps/files will be discussed in the various sections on training.

Suitability Guidelines and Allocations for Military Training

65. Suitability guidelines for various training levels must be developed prior to the preliminary military allocation phase. Training activities at Fort Benning were divided into three categories based on the amount of environmental damage that could potentially be caused by that activity. These included:

a. Heavy training (potentially severe environmental damage).
   (1) Unit vehicular training.
   (2) Combined arms operations.

b. Moderate training (potentially moderate environmental damage).
   (1) Unit infantry training.
   (2) Bivouac.

c. Light training (potentially limited environmental damage).
   (1) Individual infantry training.
   (2) Special training (e.g., bayonet, hand-to-hand, chemical agents).

66. Minimum areal needs affecting all activity and training categories were compiled, including:

a. Compartment acreages (gross and net--minus inclusions).

b. Intensity of acreage used and needed for each activity.

c. Percentage and spatial distribution.

67. The basic procedure used in this step, following construction of the necessary files and maps, is to visually assess each compartment thematically and decide the most appropriate code assignment. For example, the percentage and distribution of a given factor is evaluated and a value of suitability is assigned using subjective judgment of how the observations relate to or affect the activity under consideration. Although the strategy seems somewhat ill-defined and largely subjective, experience should guide the manager toward relatively consistent analysis.

Preliminary heavy
training activity allocation

68. For heavy training activities, environmentally sensitive sites and compartments can be eliminated before evaluating lands for heavy-duty allocations. However, it is more direct to continue the operation as a process of military-oriented assessments. Primary components considered in this allocation include:

a. Soil erosion.

b. Slopes.

c. Road access.

d. Openlands.

e. Stream bank slopes.

69. Soil erosion. Information on soil erosion potential is obtained from SCS surveys. Specific soil types in the file ENGSLS are first recoded for erosion potential obtained from tables on erosion hazards and management concerns for woodland management and productivity. Each soil type is assigned a recode value of 1 (slight potential), 2 (moderate potential), or 3 (severe potential) in the new file NWEROS. Maps resulting from the new file are then analyzed for percent coverage within the compartment for each erosion potential category. A subjective estimate of the predominant or average condition is used to rate the compartment as highly restrictive (Code 1), moderately restrictive (Code 2), or few/no restrictions (Code 3). These codes will be used in a suitability index for assigning preliminary military allocations.

70. Slopes. Slope information for the installation is contained in existing 100-m GIS files called BENNINGR and TOPOBEN (these are from existing

files called BVAR - Benning VARiable, and DEM - Digital Elevation Model - tape data). These files were overlaid with a regional mask for the northwest region to create NWSLOPE. Slope intervals in NWSLOPE were recoded to create the new file NWSLPREC (NorthWest SLope RECode):

NWSLOPE GIS Code	Interpretation	New GIS Code (NWSLPREC)	Interpretation
1	0-3%	1	0-9%
2	4-6%	1	0-9%
3	7-9%	1	0-9%
4	10-12%	2	10-18%
5	13-15%	2	10-18%
6	16-18%	2	10-18%
7	19-21%	3	19-24%
8	22-24%	3	19-24%
9	25-27%	4	25%+
10	28-30%	4	25%+
11	31-33%	4	25%+
12	34-36%	4	25%+
13	37-39%	4	25%+
14	40-42%	4	25%+
15	43%+	4	25%+
16	Area outside	5	Area outside NW compartments
		6	NW compartment boundaries

71. Similar to soil erosion above, a rating was given to each compartment based on percentage and distribution of limiting slopes (specifically to maneuverability) within each compartment. The larger the area covered by steeper slopes, the more restrictive the movement. Suitability index ratings were: 1 = highly restrictive, 2 = moderately restrictive, and 3 = few or no limitations.

72. Road access. The file NWTRANS is analyzed to determine numbers, location, and distribution of roads within each compartment. Specific codes within the NWTRANS file are:

NWTRANS GIS Codes	Interpretation
1	Compartment boundaries
2	Unimproved dirt road
3	Improved dirt road
4	Tank trail
5	Hard-surfaced road, 2 lanes
6	Hard-surfaced road, 4 lanes
7	Airfields
8	Abandoned airfields

NWTRANS GIS Codes	Interpretation
9	Landing zones
10	Drop zones
11	Helipads
12	Fording sites
13	Bridges
14	NW region mask

73. An index rating for each compartment is assigned as follows:

1 = Highly restrictive (few or no roads).

2 = Moderately restrictive.

3 = Few or no restrictions.

74. Openlands determination for maneuverability. A number of files are used to determine the extent and suitability of the compartments for vehicle maneuverability. These files are recoded to form the new file NWTFRAG (NorthWest Timber, FRAGile) as follows:

Original GIS File Name	Original GIS Codes	New GIS Codes (NWTFRAG)	Interpretation
NWTBRFT	1-23, 26, 27, 32, 33	1	Area within
	24, 25	11	Wildlife openings
	28	10	Savannahs
	29	9	Brush species
	30	8	Military
	31	6	Water
	34	7	Other, non-forest
NWTBRAG	1	12	Fragile timber (0-10 years old)
	2-16	1	Area within
	17	2	Other
NWVEG	1-10	1	Area within
	11	3	Grasslands
	12	4	Swamps
	13	5	Marshes
	14	2	Other
NWBND	1	13	Northwest compartment boundaries

75. Suitable areas within each compartment included those coded as fragile timber (0-10 years old), brush, savannahs, wildlife plots/openings, and grasslands. Unsuitable areas included military sites (designated

ranges/sites other than driving ranges), swamps, marshes, and other non-forest land. (NOTE: This is based only on potential ease of maneuvering; there is no consideration of environmental factors at this point.)

76. A rating is assigned to each compartment according to the percentage and distribution of suitable areas within each compartment:

1 = Highly suitable (extensive areas for maneuvering).

2 = Moderately suitable.

3 = Unsuitable (few or no openland areas available).

77. Stream bank slopes. Bank slope maps, with values based on CCM data on bank height (in metres) and bank slope (percentage), were constructed using information from the GIS file NWBKSLP in the following table.

Bank Height and Slope

GIS Code	Bank Height, m	Slope, %
1	<2	<15
2	<2	15-35
3	<2	35-70
4	<2	>70
5	2-6	<15
6	2-6	15-35
7	2-6	35-70
8	2-6	>70
9	>6	<15
10	>6	15-35
11	>6	35-70
12	>6	>70
13	-------Not Measured-------	

78. Suitability index ratings for each compartment are assigned after analysis of the percentage and distribution of restrictions to vehicular movement and maneuverability:

1 = Highly restrictive (large areas of GIS codes 7-8 and 10-12).

2 = Moderately restrictive.

3 = No restrictions.

79. Heavy training index. The resulting values for each component within each compartment are compiled in a simple spreadsheet (Table B2) and assigned weights of importance. Soil erosion, slopes, and stream bank slopes are given weights of 1, openlands a weight of 2, and road access a weight of 3.

80. Restriction ratings for each component are multiplied with the weighting factor and summed for each compartment to produce an additive index

Table B2

Site Suitability Index and Preliminary Allocations for Unit Vehicular Training in the Northwest Region of Fort Benning, GA

Compartment	Soil Erosion (W = 1)	Slopes (W = 1)	Road Access (W = 3)	Open-Lands (W = 2)	Stream Bank Slopes (W = 1)	Additive Index Rating (AI)*	Preliminary Allocation
M11	FR	MR	FR	U	MR	18	P
M12	FR	FR	MR	U	MR	16	S
N01	FR	MR	FR	MS	HR	19	P
N02	FR	MR	HR	U	FR	13	S
002	FR	MR	HR	MS	FR	15	S
003	FR	MR	MR	U	MR	15	S
004	FR	MR	MR	U	MR	15	S
005	FR	FR	FR	HS	FR	24	P
006	FR	FR	FR	MS	MR	21	P
007	FR	MR	MR	U	MR	15	S
008	FR	MR	HR	U	FR	13	S
009	FR	HR	MR	U	FR	15	S
010	FR	MR	FR	HS	FR	23	P
011	FR	MR	MR	U	MR	15	S
012	FR	MR	MR	U	FR	16	S
013	FR	HR	FR	U	MR	17	S
014	FR	MR	FR	U	FR	19	P
015	FR	MR	FR	MS	HR	19	P

NOTE: P = primary
S = secondary
AI = additive index rating
W = weighting
*AI = (RR1 * W1) + (RRZ * WZ) +....+ (RRn * Wn)
RR = restriction rating
HR = highly restrictive (1)
MR = moderately restrictive (2)
FR = few or no restrictions (3)
HS = highly suitable (1)
MS = moderately suitable (2)
U = unsuitable (3)

rating. Compartments with an additive index rating of 18 or greater are allocated as primary for unit vehicular training (preliminary allocation).

Preliminary moderate
training activity allocations

81. The procedure for moderate activity allocations (equivalent to infantry foot training) is similar to that of heavy duty activity allocations except that different files are used. In place of soil erosion, slopes, and road access, etc., the following files are used: concealment from air (NWCAMFA), concealment from ground (NWCAMFG), and cover from flat trajectory of small arms (NWFTCOV). Bivouac limitations (NWTRGBV), are used for evaluating new bivouac sites.

82. Concealment from air and ground observation. Vegetation maps from the Fort Benning Cross-Country Mobility Atlas were originally digitized into the file NWVEG and then recoded into the new file NWCAMOF to show the combined potential for concealment of troops from air and ground observation. Construction of this new file is as follows:

NWVEG GIS Codes	NWVEG Interpretation	NWCAMOF GIS Codes	NWCAMOF Interpretation
1	Coniferous, open to medium spacing	3	1 = Other, no value
2	Coniferous, medium to dense spacing	4	2 = Poor to fair, all year, air/ground
3	Deciduous, open to medium spacing	2	3 = All year: air - poor; ground - fair
4	Deciduous, medium to dense spacing	6	4 = Fair to good, all year, air/ground
5	Mixed coniferous/deciduous, open to medium spacing	2	5 = Fair to good, April to October, air/ ground, poor to fair rest of year
6	Mixed coniferous/deciduous, medium to dense spacing	5	6 = Good, April to October, air/ground poor rest of year
7	Scrub oak, open to medium spacing	2	
8	Scrub oak, medium to dense spacing	5	
9	Mixed scrub oak/coniferous, open to medium spacing	2	

NWVEG GIS Codes	NWVEG Interpretation	NWCAMOF GIS Codes	NWCAMOF Interpretation
10	Mixed scrub oak/coniferous, medium to dense spacing	5	
11	Short grasses (<1 m) and field crops	2	
12	Swamps, wet areas with >50% trees	5	
13	Marshes, wet areas with >50% grasses	2	
14	Other	1	
15	Area outside (mask)	0	

83. NWCAMOF was further recoded into two new files, NWCAMFA and NWCAMFG, to show the concealment potential from air and ground, respectively.

NWCAMOV GIS Code	NWCAMFA GIS Code	NWCAMFG GIS Code	Interpretation
1	1	1	1 = Other, no value
2	2	2	2 = Poor to fair, all year
3	2	3	3 = Fair to good, all year
4	3	3	4 = Fair to good, April to October; poor to fair for all else
5	4	4	5 = Good, April to October; poor for winter

84. Suitability index ratings were assigned to each compartment based on the percentage and distribution of the following restriction codes, first for concealment from air and then for concealment from ground:

1 = Poor to fair concealment all year (Highly restrictive)

2 = Poor to fair concealment, winter; fair to good concealment, summer (Moderately restrictive)

3 = Fair to good concealment all year (Non-restrictive)

85. Concealment from flat trajectory of small arms. This information was also derived from the NWVEG file classifications, using the same interpretations as above for NWVEG. Recoded values from NWVEG resulted in the new file NWFTCOV. These are constructed as follows:

NWVEG GIS Codes	New GIS Code (NWFTCOV)	Interpretation
1	3	1 = Other, no value
2	5	2 = No cover from flat trajectory
3	3	3 = Poor cover from flat trajectory
4	4	4 = Poor to fair cover in widely spaced stands; fair to good cover in dense stands
5	3	5 = Fair cover in widely spaced stands; good cover in dense stands
6	5	
7	3	
8	3	
9	3	
10	3	
11	2	
12	3	
13	2	
14	1	
15	0	

86. Suitability index ratings were based on the percentage and distribution of the following restriction codes within each compartment and then assigned to each compartment accordingly.

1 = Poor concealment all year (Unsuitable)
2 = Fair to good concealment all year (Suitable)

87. Special requirements. Special requirements considered in the moderate training activity allocation include:

a. Specific training areas, such as compass or obstacle courses, AO Yellow, etc.

b. Established bivouac sites.

88. Although these are not applied in the suitability index, they are used to define specific areas that must be either excluded from the allocation or given special consideration.

89. Moderate training index. Values similar to those for the heavy training index are also assigned for the moderate training index. Each

suitability variable (i.e., cover from air, cover from ground, and cover from flat trajectory of small arms) is given equal importance with a weighting of 1. Table B3 shows these values and the resultant allocation of compartments for moderate training activities.

Preliminary light
training activity allocations

90. Light training activities are allocated to all compartments due to their minimal impacts. However, certain special requirements that will be considered during conflict resolution include the presence or absence of special individual training courses, such as bayonet, hand-to-hand combat, and physical training areas.

Table B3

Site Suitability Index and Preliminary Allocations for Unit Infantry Training in the Northwest Region of Fort Benning, GA

Compartment	Concealment From Air (W = 1)	Concealment From Ground (W = 1)	Cover from Fire of Small Arms (W = 1)	Additive Index Rating (AI)	Preliminary Allocation
M11	FS/PW	FA	FG	7	P
M12	FS/PW	FS/PW	FG	6	S
N01	FS/PW	FA	FG	7	P
N02	FA	FA	FG	8	P
O02	FS/PW	FS/PW	FG	6	S
O03	PA	FA	PC	5	S
O04	PA	FA	PC	5	S
O05	FS/PW	FA	PC	6	S
O06	FS/PW	FA	FG	7	P
O07	FS/PW	FS/PW	FG	6	S
O08	FS/PW	FA	FG	7	P
O09	FS/PW	FS/PW	FG	6	S
O10	FS/PW	FS/PW	FG	6	S
O11	FS/PW	FS/PW	PC	5	S
O12	FS/PW	FS/PW	FG	6	S
O13	FS/PW	FS/PW	FG	6	S
O14	FS/PW	FS/PW	FG	6	P
O15	FS/PW	FS/PW	FG	6	P

Note: P = primary
S = secondary
AI = additive index rating (RR1*W1)+(RR2*W2)+...+(RRn*Wn)
n = number of variables
W = weighting
RR = restriction ratings
PA = poor to fair all year = 1
PW = poor to fair all winter = 2
FS = fair to good all summer = 2
FA = fair to good all year = 3
PC = poor cover = 1
FG = fair to good cover = 2

PART V: PHASE III, CONFLICT RESOLUTION

Introduction

Overview

91. Final allocations are made on the basis of multiple use--optimization of the several possible natural resource and/or military uses that could be applied to the land. A process of conflict resolution is used to reduce the preliminary selections to an optimum set: for each compartment, initial natural resource and military assignments are paired and conflicts or incompatibilities are then resolved. For example, one activity could be excluded to insure the success of those remaining. The working premise is to keep as many uses in a compartment as possible, while striving to maintain environmental quality (as decided by the land manager). This is an iterative process and may require several attempts to reach a final allocation.

92. Phase III steps. The following steps are included in Phase II of the allocation process:

a. Construct and compare cross-compatibility matrix.

b. Determine specialized compartments.

(1) Exclusives.

(2) Potential exclusives.

c. Perform the conflict resolution process.

(1) Determine exclusions.

(2) Answer conflict resolution questions.

(3) Examine special considerations.

(4) Map semi-final allocations.

(5) Review and finalize allocations.

93. The primary ERDAS routine used in Phase III is RECODE.

Construct and Compare Cross-Compatibility Matrix

Basic procedure.

94. Preliminary military and natural resource allocations have been made independently and concurrently and incompatibilities exist in some compartments. The next step is to resolve the conflicts in each compartment so that final synoptic assessment for thematic and spatial balance can occur.

Table B4 is a cross-compantibility matrix, comparing the suitability of each activity with all others. When compared with Table B1, a listing of preliminary assignments, it is used to guide each compartment's allocations. The basic objective is to maximize the number of uses within each compartment but not at the expense of a proper balance or mix of variety. All activities should have compartment assignments; none should be excluded just to favor maximization.

95. During the conflict resolution process, one or two "primary" allocations and one or more "secondary" assignments may result for each compartment. Conflict resolution begins with the identification of specialized compartments, followed by detailed analysis of each compartment's physical data on preliminary allocations.

Specialized Compartments

96. The allocation process selects the best military and/or natural resource activities for each compartment. Rather than beginning with an empty matrix of unassigned compartments and activities, from which a complex assignment routine would be necessary, compartments with predetermined or delegated uses should be identified first. Because some compartments have existing (and sometimes permanent) uses, all or part of their allocation has been predetermined. During this phase of regional examination (or even throughout the allocation process) three levels of special compartment assignment should be undertaken: (a) exclusives, (b) potential exclusives, and (c) dedicated compartments.

Exclusives

97. Some compartments contain areas with exclusive uses (firing ranges, impact areas, or housing areas) that are incompatible with most other military and natural resource activities. These should be identified and delineated accordingly, essentially making them off-limits for other allocations. Also, the presence of features that cannot be readily changed will influence the allocation of that compartment. For example, the presence of elaborate training structures (e.g., obstacle courses that may be impractical to move) suggests that the compartment be allocated to individual infantry training, although other uses may be assigned if they are compatible.

Table B4

Compatibilities and Potential Conflicts Between Natural Resource and Military Allocations

Allocations	Wildlife RCW	Wildlife GT	Arch/Hist Sites	Special Military Sites	Loblolly Pine	Mixed Pine	Mixed Pine and Hardwood	Unit Vehicular Training	Unit Foot Training	Combined Arms Training	Established Bivouac	New Bivouac
Wildlife:	-	-	-	-	-	-	-	-	-	-	-	-
RCW	NA	C	C	P[3]	C	C	I	I	C[2]	I	P[8]	I
GT	C	NA	C	P[3]	C	C	C	I	C[2]	I	P[8]	I
Arch/hist sites	C	C	NA	I	P[1]	P[1]	P[1]	C[2]	I	P[8]	I	
Special military sites	P[3]	P[3]	I[9]	NA	P[5]	P[5]	P[5]	P[6]	P[6]	P[6]	C	I
Loblolly pine	P[1]	P[1]	P[1]	P[5]	NA	C[7]	C[7]	P[4]	C	P[4]	C	P[8]
Mixed pine	P[1]	P[1]	P[1]	P[5]	C[7]	NA	C[7]	P[4]	C	P[4]	C	C
Mixed pine & hardwood	P[1]	P[1]	P[1]	P[5]	C[7]	C[7]	NA	P[4]	C	P[4]	C	C
Unit vehicular training	I	I	I	P[6]	P[4]	P[4]	P[4]	NA	I	C	C	P[8]
Unit foot training	C[2]	C[2]	C[2]	P[6]	C	C	C	I	NA	C	C	C
Combined arms trng	I	I	I	P[6]	P[4]	P[4]	P[4]	C	C	NA	C	P[8]
Established bivouac	P[8]	P[8]	P[8]	C	C	C	C	C	C	C	NA	C
New bivouac	I	I	I	I	P[8]	C	C	P[8]	C	P[8]	C	NA

RCW = Red-cockaded woodpecker GT = Gopher tortoise Arch/hist = Archaeological/historical sites
C = Compatible I = Incompatible P = Possible compatible*

* = Possibly compatible under specified conditions: potential conflicts exist but can be modified or rearranged for compatibility--resource management decisions needed.

1 = Resource management decisions needed: Possibly compatible if timber harvests are not within the actual designated arch/hist sites or if non-destructive harvesting techniques are used--use subcompartments if needed.

2 = Scale dependent--compatible in large areas (compartments and large stands) but not suitable in small areas (e.g., avoid bivouac establishment in sensitive wildlife food plot)--avoid direct intensive disturbance.

3 = Possibly compatible if wildlife are not within the actual designated military ranges/sites (may be dependent upon the training activity)--use subcompartments for compatibility.

4 = Possibly compatible if timber harvests are used to enhance training activity--certain cutting practices may conflict with specific activities. Also, possibly compatible based on spacing and age vs. training needs, i.e., widely spaced and/or older trees are less susceptible to being run over.

5 = Possibly compatible if timber harvests are not within the actual designated military ranges/sites--use subcompartments.

6 = Possibly compatible if training activities do not occur within the actual designated military ranges/sites.

7 = Resource management decisions needed: possibly compatible if silvicultural prescriptions are compatible, and timber harvests are not within the actual designated arch/hist sites--use subcompartments if needed and use non-destructive harvesting techniques.

8 = Dependent upon military use of site; resource management decision needed. Example: training area may or may not allow bivouacking.

9 = Applies only to destructive or potentially destructive military activities.

98. Additionally, because of environmental or spatial constraints, some compartments may not be suitable for particular types of activities and therefore these should be excluded at the beginning, before allocation decisions are considered. For example, swamp areas are not suitable for tank training; these areas should probably be allocated to dismounted infantry training. Also, compartment adjacent to cantonments (housing areas) obviously are not appropriate as impact areas or vehicular driving ranges.

Potential exclusives

99. Other compartments may be environmental or military attributes that warrant consideration as a "potential exclusive" classification. For example, a compartment composed mostly of very young pine (0-10 years old) should be left idle to allow the pine to mature; this action potentially makes this an "exclusive" compartment. These should be identified and set aside for special attention in the allocation process. If unable to dedicate as a single-use or single-theme compartment, interference with its primary purpose will be minimized in the allocations.

100. One possible strategy to use when there are incompatibilities, especially in the "exclusive" and "potentially exclusive" compartments, is the formation of subcompartments. This involves the reduction or subdivision of compartments to unique and inviolate areas (or special sites), which are considered independent of other allocations. Using the fragile young pine example from above, there may be too much competition for other potential uses to be able to designate the total compartment as "exclusive" for pine management. If the young pines occupy a distinctive area, formation of subcompartments will delineate the area as a separate allocation entity. Thus, the young trees will be effectively protected while allowing other uses in the remainder of the compartment. Obviously, the creation of subcompartments depends on favorable spatial distribution or aggregation of the pines and will not work if they are scattered throughout the compartment.

The Conflict Resolution Process

Exclusion

101. To insure maximum multiple uses, a process of "exclusion" is used: all preliminary allocations remain unless a case for exclusion can be made. The working assumption is that each allocation automatically prevails unless a

special reason for its rejection exists. This type of process is used instead of constructing an elaborate justification of compatibility with all other assigned uses.

Conflict resolution questions

102. Comparing Table B4 (compatibility matrix) to Table B1 (preliminary compartment allocation), a short series of questions is addressed for each compartment and a table similar to Table B5 is constructed. (NOTE: All activities do not have a primary allocation in this example. When all regions are compared, this may change.) Using P for primary and S for secondary semi-final allocations, the questions are as follows:

a. If there is only one P, it is a rational allocation? For example, if a compartment is allocated for mixed pine and hardwood management but has a very high site index for loblolly pine, should the compartment be reallocated to loblolly pine management? Because subcompartments do not share allocations, this process normally will be unnecessary for them.

b. Are all primary allocations compatible with each other? It is possible that a fundamental incompatibility exists, e.g., between unit vehicular training and endangered species allocations. The most obtrusive or detrimental primary allocation should be excluded, based on the nature of the potential secondaries. In this example, if most of the secondaries are forest- or natural-resource-oriented, perhaps a wildlife allocation should be kept at the expense of the military.

c. Are all P's compatible as primary allocations? Although several activities may coexist, they may not be compatible as the major allocations. One primary may need reallocation to secondary or should be excluded. For example, a compartment is given two primary allocations; one is a special military training site (e.g., a bivouac site) and the other is unit vehicular training. These activities are possibly compatible if the unit vehicular training is not conducted within the designated bivouac site and is reallocated as a secondary activity for the compartment. The resource manager must decide which activity takes precedence.

d. Are all P's compatible with the secondaries? To optimize the multiple use of each compartment, the initial goal is to allocate as many activities as possible. Normally, primaries take precedence and all incompatible secondaries should be excluded. However, judgment may be needed for some cases. For example, if the single primary activity is incompatible with multiple secondaries, perhaps the primary should be excluded in order to preserve an optimum number of uses. Also, a primary activity's priority may interfere with the secondary activities; by reallocation from primary to secondary, conflicts may be avoided. Major reevaluations should be

Table B5

Semi-Final Primary and Secondary Allocations for Northwest Region Compartments of Fort Benning, GA After Resolution of Conflicts

Compartment	Wildlife RCW & GT	Arch/Hist Sites	Special Military Sites	Loblolly Pine	Mixed Pine	Mixed Pine & Hardwood	Unit Vehicle	Unit Foot	Bivouac	Open, No Decision	Possible Subcompt	Total P	Total S
M11		S				P	S	P	S		M	2	3
M12		S			P		S	S	S		AH & RCW	1	4
N01	S	S		P				P				2	2
N02				P				P	S			2	1
002						P	S	S	S			1	3
003	P	S			S			S				1	3
004	S				P		S	S	S		GT	2	3
005				S	S		P	S	S			3	2
006	S			P	S		S	P	S		GT	4	2
007		S		P		S		S				1	5
008	S	S			S			P	S		GT	3	4
009		S	P				S	S	S			2	3
010	S						P				RCW & M	3	2
011		S	P									2	3
012					P		S	S	S			2	2
013	S	S	S		P		S	S	S		RCW	2	4
014	S	S	S	P			P	S	S		RCW	3	3
015	P	S	S	S								3	3
Total P's	2	0	2	5	4	2	3	5	0	0		23	
Total S's	7	11	3	2	4	1	8	10	12	0			58
Totals	9	11	5	7	8	3	11	15	12	0		81	

Note:
P = primary
S = secondary
AH = archaeological/historical
GT = gopher tortoise
RCW = red-cockaded woodpecker
M = military

Double Primaries

1 Mixed pine/hardwood and unit foot
1 Loblolly pine and unit vehicle
3 Loblolly pine and unit foot

avoided if possible, although they may be necessary for successful conflict resolution.

e. Are all secondaries compatible with each other? Consideration of the nature of the primary activities as well as each secondary is necessary. The most detrimental secondaries should be excluded. Timber harvests, for example, should not occur within designated archaeological or historical sites, unless non-destructive harvesting techniques are used. If these activities are still in conflict, then timber harvests should be excluded to preserve the archaeological/historical sites.

Special considerations

103. To ensure an acceptable range of assignments, a quick assessment of the spatial and thematic balances of natural resource and military primary allocations is made. Tabulation of each compartment's primary and secondary allocations provides a suitable overview of the results.

104. There is a tendency to assign vehicular training to every compartment. However, this is largely incompatible with the protection of sensitive activities. Conversely, there is an inclination to allocate sensitive activities to every site or space where they occur. Obviously, neither category can receive the bulk of allocations in an installation. Secondary assignments of vehicular training and sensitives can be accommodated, but care must be taken to ensure the success of both. If sensitive activities are distributed evenly over the compartment, perhaps vehicular activity should not be allocated. However, some clustering of sensitive activities, even if too few to establish subcompartments, may allow both uses to coexist. Resource managers and military planners must work in unison in such cases to avoid conflicting biases.

Map semi-final allocation

105. The next major step is to map the allocations for a comprehensive, synoptic view of results. This is a useful perspective to assess synoptic distribution of allocations, which may reveal a need to redistribute assignments.

106. The S at the end of each file name signifies "semi-final" and is replaced by an F for final map versions. The sequence of maps should proceed from general to specific. All maps are created by recoding each compartment in the NWCRNR file to the new code representing an allocation.

a. Generalized primary allocations of the region (includes subcompartments):

New GIS Code	Interpretation
1	Military primary only
2	Sensitives only
3	Timber only
4	Timber and military
5	Timber and sensitives
6	Military and sensitives

New File: NWGENPAS (NorthWest GENeral Primary Allocations, Semi-final)

b. Detailed primary allocations (showing combinations):

New GIS Code	Interpretation
1	Wildlife (RCW and GT)
2	Arch/historic sites
3	Special military sites
4	Loblolly pine
5	Mixed pine
6	Mixed pine and hardwood
7	Unit vehicular training
8	Unit foot training
9	Bivouac
10	Loblolly and unit vehicle
11	Loblolly and unit foot
12	Mixed pine/hardwood & unit foot
13	Military subcompartment
14	Arch/hist and RCW subcompartment
15	Gopher tortoise subcompartment
16	RCW Subcompartment

New File: NWDETPAS (NorthWest DETailed Primary Allocations, Semi-final)

c. Theme maps -each general category:

Theme	New GIS Code	Interpretation
Wildlife	1	Primary
	2	Secondary
	3	Subcompartments
	4	No allocation

File: NWWILALS (NorthWest WILdlife ALlocations, Semifinal)

Arch/historic	1	Primary
	2	Secondary
	3	Subcompartments
	4	No allocations

New File: NWAHALS (NorthWest Arch/Hist ALlocations, Semifinal)

Theme	New GIS Code	Interpretation
Loblolly	1	Primary
	2	Secondary
	3	No allocation

New File: NWLOBALS (NorthWest LOBlolly ALlocations, Semifinal)

Mixed pine	1	Primary
	2	Secondary
	3	No allocation

New File: NWMPALS (NorthWest Mixed P. ALlocations, Sem al)

Mixed pine/ hardwood	1	Primary
	2	Secondary
	3	No allocation

New File: NWMPHALS (NorthWest Mixed Pine and Hardwood ALlocations, Semifinal)

Unit vehicular	1	Primary
	2	Secondary
	3	Subcompartments
	4	No allocation

New File: NWUVALS (NorthWest Unit Foot ALlocations, Semifinal)

Unit foot	1	Primary
	2	Secondary
	3	Subcompartments
	4	No allocation

New File: NWUFALS (NorthWest Unit Foot ALlocations, Semifinal)

Bivouac	1	Primary
	2	Secondary
	3	Subcompartments
	4	No allocation

New File: NWBIVALS (NorthWest BIVouac ALlocations, Semifinal)

Special sites	1	Primary
	2	Secondary
	3	Subcompartments
	4	No allocation

New File: NWSSALS (NorthWest Special Sites ALlocations, Semifinal)

Review and finalization

107. The final steps involve review and confirmation, or change, of the regional allocations, followed by "stitching" regions into an installation-wide map for review. This affords a useful perspective to assess the distribution of allocations, which may reveal a need to redistribute allocations. Installation policy may prescribe a distinct spatial distribution or use pattern. For example, most of the unit infantry training may be concentrated in one corner of the compartment, region, or installation, where terrain and vegetation present few difficulties for troop movement. However, the command may require a diversity of training environments, including difficult ones, for thorough training. Consequently, readjustment of allocations may be necessary, resulting in the reallocation of primaries and secondaries. This is an iterative process which may take several cycles of readjustment to finalize. Once the final regional allocations have been made, regions are "stitched" into an installation-wide mosaic and the above evaluations are made again, at the new scale and perspective. Once installation allocations are finalized, definitive maps are produced, using the nomenclatures above, but replacing the S with F.

Tab 1, Appendix B: GIS File Names

GIS FILE NAMES

All file names may be prefaced by letters to signify the region of the installation (e.g., NW for Northwest).

Inventory Files

Timber - Compartment and Regional

- TBR - Timber stands
- TBRFT - Specific forest types
- *GENFT - General forest types - recoded TBRFT
- *COMFT - Commercial forest types - recoded TBRFT
- TBRAG - Timber stand age classes - recoded TBR
- TBRCC - Timber stand age condition classes - recoded TBR
- TBROP - Timber operability classes - recoded TBR
- TBRSI - Timber site index classes - recoded TBR
- TBRBD - Used SCAN to create timber stand boundaries

Soils

- SLS - Specific soil types

Wildlife

GSHSI	- Stand grey squirrel HSI's	(compt)
BWHSI	- Stand bobwhite quail HSI's	(compt)
DRHSI	- Stand white-tailed deer HSI's	(compt)
WTHSI	- Stand Eastern wild turkey HSI's	(compt)
RRHSI	- Stand RCW reproduction HSI's	(compt)
RFHSI	- Stand RCW foraging HSI's	(compt)
GSQHSI	- Compartment grey squirrel HSI's	(regional)
BWQHSI	- Compartment bobwhite quail HSI's	(regional)
WTDHSI	- Compartment white-tailed deer HSI's	(regional)
EWTHSI	- Compartment Eastern wild turkey HSI's	(regional)
RCRHSI	- Compartment RCW reproduction HSI's	(regional)
RCFHSI	- Compartment RCW foraging HSI's	(regional)
RCW	- Red-cockaded woodpeckers - field data and old data	(compt and regional)
ESP	- Endangered species (gopher tortoise and RCW's) old data (BVAR)	(regional and compt)
*ENDSP	- Endangered species (gopher tortoise and RCW's) old data and field	

Miscellaneous BVAR files

- AH - Combination of archaeological and historical sites
- AIR - Air pollution
- BVSLS - Engineering (BVAR) soils general associations
- CCM - Cross-country movement (maneuverability)
- GLC - Engineering geology - earth materials associations
- HYD - Hydrology - surface water availability
- NSE - Noise ICUZ contours

WLD - wildlife habitat
WTL - wetlands - swamps and marshes

Military

CCM - Cross-country movement (BVAR data)
CCMSL/CCMSLP - Slopes derived (recoded) from cross-country movement
ROADS - Roads-from dirt to hard surfaced
BVLIM/BIVLIM - Bivouac limitations (for establishing new sites)- recoded BVSLS
TRANS - Transportation (avenues of)
CULT - Other cultural features - buildings, towers, pits, revetments, bleachers
FORDS - Fording sites/stream crossings
BRGS - Bridges
BKGAP - Stream bank gaps
BKSLP/BKSLOP - Stream bank heights & slopes
FIRPTS - Firing points
PITS - Miscellaneous pits
HPADS - Helipads
ZONES - Miscellaneous airfields and landing zones
MISC - Miscellaneous military features/structures
MISRG/MISRNG - Miscellaneous military ranges, towers, OP's and FP's (observation and firing points)
RNG - Miscellaneous military ranges
CAMOF - Camouflage/concealment from air and ground for foot troops - RECODED VEG
CAMOV - Camouflage/concealment from air and ground for vehicles - RECODED VEG
CAMFA - Camouflage/concealment from air for foot troops - RECODED CAMOF
CAMFG - Camouflage/concealment from ground for foot troops - RECODED CAMOF
FTCOV - Cover from flat trajectory of small arms - RECODED VEG
TFRAG - Fragile timber areas-used for openland determination
TRGBV - Special military training areas (dedicated)
EROS - Soil erosion hazard from SCS data
SLOPE - 100-m resolution slope data from original BVAR and DEM tape data
SLPREC - Recoded slope data for military training allocations

Other

QUAD/REGION - each individual compartment within each region
MASK - compt. and region masks (transparent)
BNDS - used SCAN to create compartment/region boundaries - w/o outside edge
BNDRY - used SCAN to create compartment/region boundaries including zeros

Preliminary Analysis/Manipulation Files

Compartment and regional

ENDSP - Endangered species (GT and RCW) - (OVERLAY) combination of old and new (field) data

RCBUF - RCW buffer zones (60 m)
GTBUF - Gopher tortoise buffer zones (60 m)
AHBUF - Arch/hist buffer zones (100 m)

Regional

RECSI - General site index classes - RECODED TBRSI
WLSEN - Overlay RCBUF and GTBUF - wildlife sensitive sites
SISEN - Overlay AHBUF, WLSEN, RECSI - recorded site index and sensitive sites
PRETAL - Preliminary timber allocations - MATRIX SISEN and TBRFT
TIMALO - Preliminary timber allocations with ages - MATRIX PRETAL and TBRAG
LOBAL - Loblolly pine allocations - RECODED TIMALO
TIMGSQ - Matrix TIMALO and GSQHSI - combined timber allocations and generalized grey squirrel
TIMBWQ - Matrix TIMALO and BWQHSI - combined timber allocation and generalized BWQ HSI
TIMWTD - Matrix TIMALO and WTDHSI - combined timber allocation and generalized WTD HSI
TIMEWT - Matrix TIMALO and EWTHSI - combined timber allocation and generalized EWT HSI
TIMRCR - Matrix TIMALO and RCRHSI - combined timber allocation and generalized RCR HSI
TIMRCF - Matrix TIMALO and RCFHSI - combined timber allocation and generalized RCF HSI

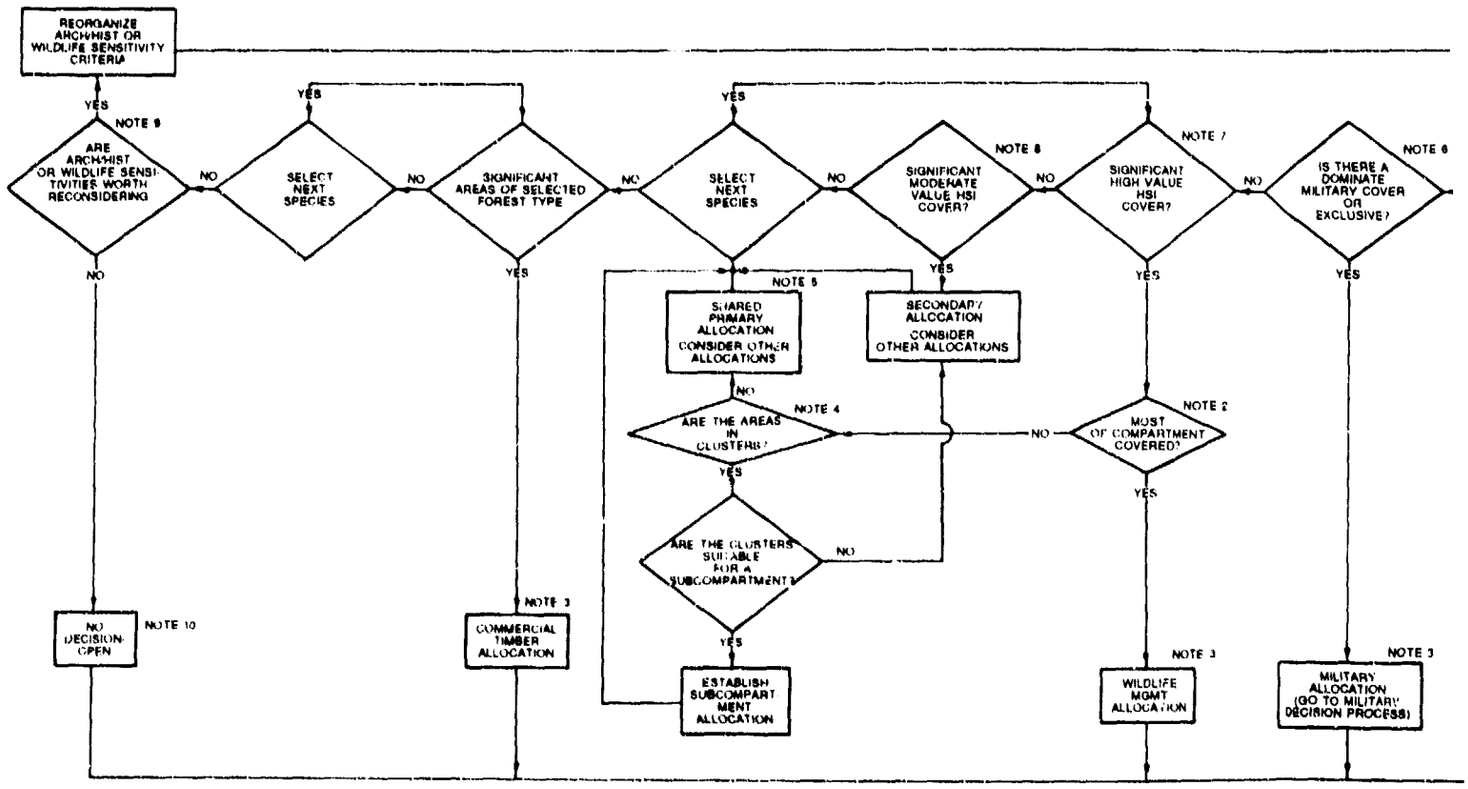
Allocation Files after Conflict Resolution (Regional)

GENPA (S/F*) - Generalized primary allocations - RECODED QUAD/REGION
DETPA(S/F) - Detailed primary allocations - RECODED QUAD/REGION
WILAL(S/F) - Wildlife allocations
AHAL(S/F) - Arch/Hist allocations
LOBAL(S/F) - Loblolly pine allocations
MPAL(S/F) - Mixed pine allocations
MPHAL(S/F) - Mixed pine/hardwood allocations
UVAL(S/F) - Unit vehicular allocations
UFAL(S/F) - Unit foot/infantry allocations
BIVAL(S/F) - Bivouac allocations
SSAL(S/F) - Special sites allocations

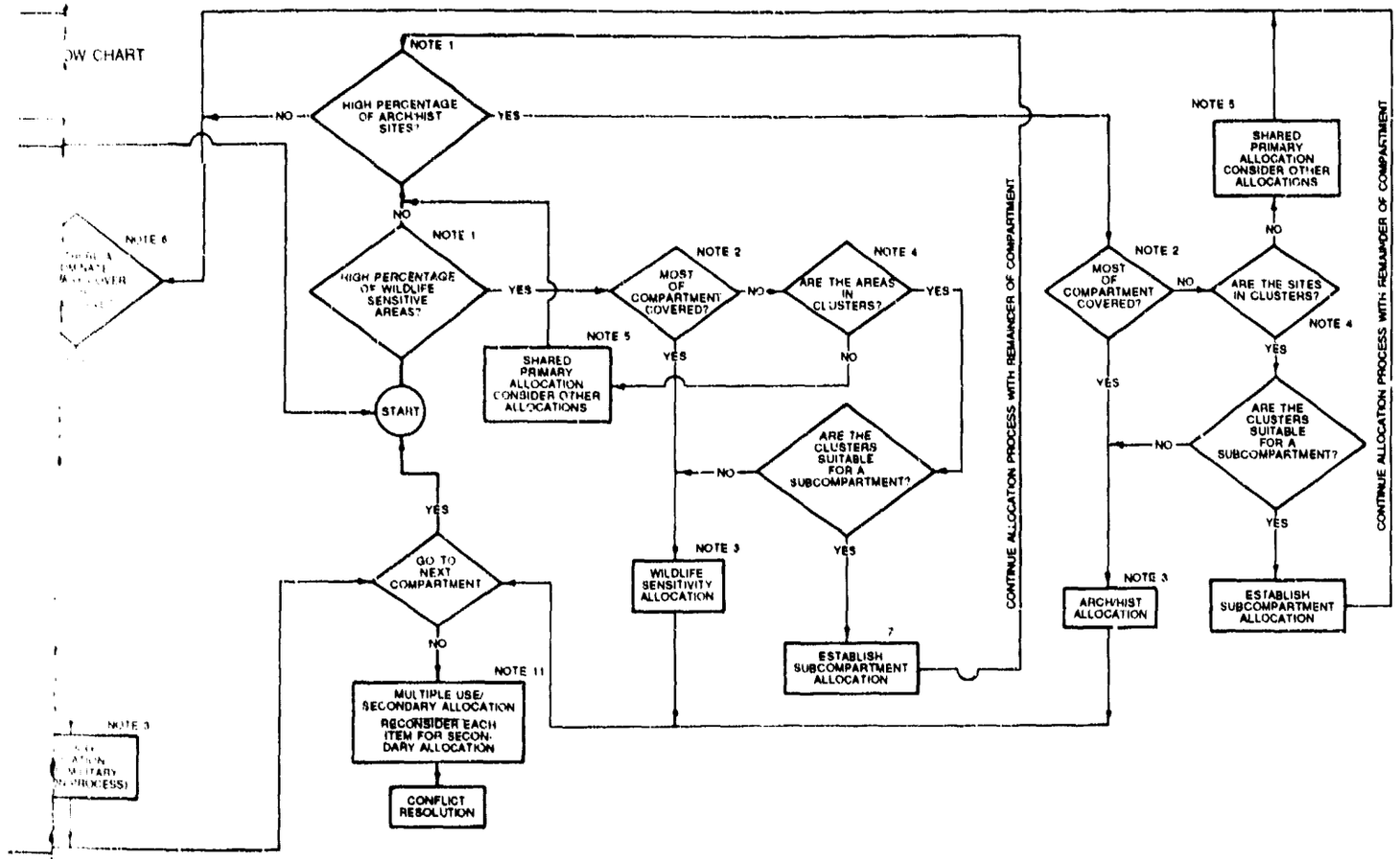
*S = semifinal allocation, F = final allocation

Tab 2, Appendix B: Allocation Decision Flowchart

ALLOCATION DECISION FLOW CHART



OW CHART


NOTE 1
HIGH PERCENTAGE OF ARCH/HIST SITES?
NO
YES
NOTE 6
NOTE 1
HIGH PERCENTAGE OF WILDLIFE SENSITIVE AREAS?
YES
NOTE 2
MOST OF COMPARTMENT COVERED?
NO
NOTE 4
ARE THE AREAS IN CLUSTERS?
YES
NO
YES
NOTE 5
SHARED PRIMARY ALLOCATION CONSIDER OTHER ALLOCATIONS
START
YES
GO TO NEXT COMPARTMENT
NO
NOTE 11
MULTIPLE USE/ SECONDARY ALLOCATION
RECONSIDER EACH ITEM FOR SECONDARY ALLOCATION
CONFLICT RESOLUTION
NOTE 3
WILDLIFE SENSITIVITY ALLOCATION
NO
ARE THE CLUSTERS SUITABLE FOR A SUBCOMPARTMENT?
YES
7
ESTABLISH SUBCOMPARTMENT ALLOCATION
CONTINUE ALLOCATION PROCESS WITH REMAINDER OF COMPARTMENT
NOTE 2
MOST OF COMPARTMENT COVERED?
NO
NOTE 4
ARE THE SITES IN CLUSTERS?
YES
NO
NOTE 5
SHARED PRIMARY ALLOCATION CONSIDER OTHER ALLOCATIONS
YES
NO
ARE THE CLUSTERS SUITABLE FOR A SUBCOMPARTMENT?
YES
NOTE 3
ARCH/HIST ALLOCATION
ESTABLISH SUBCOMPARTMENT ALLOCATION
CONTINUE ALLOCATION PROCESS WITH REMAINDER OF COMPARTMENT

NOTES

Item number

1. "High percentage of wildlife sensitivity cover or arch/hist sites?" designates that no objective percentage of cover is suggested. Magnitude of "significant" occurrence is a managerial decision.

2. "Most of compartment covered?" designates at least 50-percent coverage.

3. If the primary allocation has been made, then all other rational uses are automatically allocated as secondaries. Conflict resolution will refine.

4. "In clusters?" asks for judgment in spatial grouping or assembly for potential subcompartmentalization. If yes, protective subcompartments are established, which are maintained as exclusive sites for the theme.

5. If areas are not in clusters, the theme must be allocated as shared primary, meaning that other categories may share the compartment if there are not apparent conflicts.

6. Some compartments are obviously military and may be ranked as "exclusives"--no other use can be allocated.

7. High HSI values (species dependent) denote land suitable for wildlife management (as opposed to protection of endangered or threatened species).

8. Moderate HSI values denote land suitable for wildlife management, but unsuitable as a primary site. This land should be shared as co-primary allocation.

9. At this point, it is possible that no allocations have been made; however, because sensitives have a statutory mandate, they should be reconsidered before elimination.

10. "No Decision--Open" connotes that no outstanding category exists and no resource allocations have been made. This is not likely to occur often. Military allocations or secondaries without a primary can result.

11. The multiple-use concept is exemplified by including all rational unallocated uses unless a case can be made for exclusion.

APPENDIX C: LANDMENU MANUAL

APPENDIX C: LANDMENU MANUAL

PART I: INTRODUCTION

1. The LANDMENU automated system is a menu-driven computer program providing the natural resources manager with an effective method to assist determining the proper use of land in relation to available timber and wildlife information. The system provides for the storage, computation, and reporting of timber volumes and habitat suitability information. The user provides the field plot data, stand designations, and forest compartment prescription summary. Output can be incorporated into a geographic information system for graphic presentation.

2. The system operates on IBM-compatible computers using Microsoft Disk Operating System (MS DOS) Version 2.11 or higher. The software is written in dBASE III Plus, with subsystems compiled by Clipper (1986). At the end of processing, the system automatically makes a floppy disk backup of the compartment.

How the System Works

3. After the field data are recorded on the data sheets (Figure C1), the data are entered into the computer by the data entry operator. Two operations are required: (a) the field plot data (Figure C2) must be entered (b) the compartment prescription summary (Figure C3) must also be entered. Once the data are entered, they must be checked for accuracy. Here, the operator prints the data listings (Figure C4) and goes to the edit routine to make corrections (Figures C5, C6, and C7). The computations are executed once the data are accurate. The results of these computations give the natural resources manager a picture of the existing timber volumes and wildlife conditions at the time of data collection. Detail and summary reports can be seen in Tab 1: Reports.

How the System Operates

4. When the computer is switched on, the system boots to give the screen shown in Figure C8. The user should select the LANDMENU option (L).

COMPARTMENT D15 DATE 2/10/87 CREW EVANS/BISHOP/YOUNG

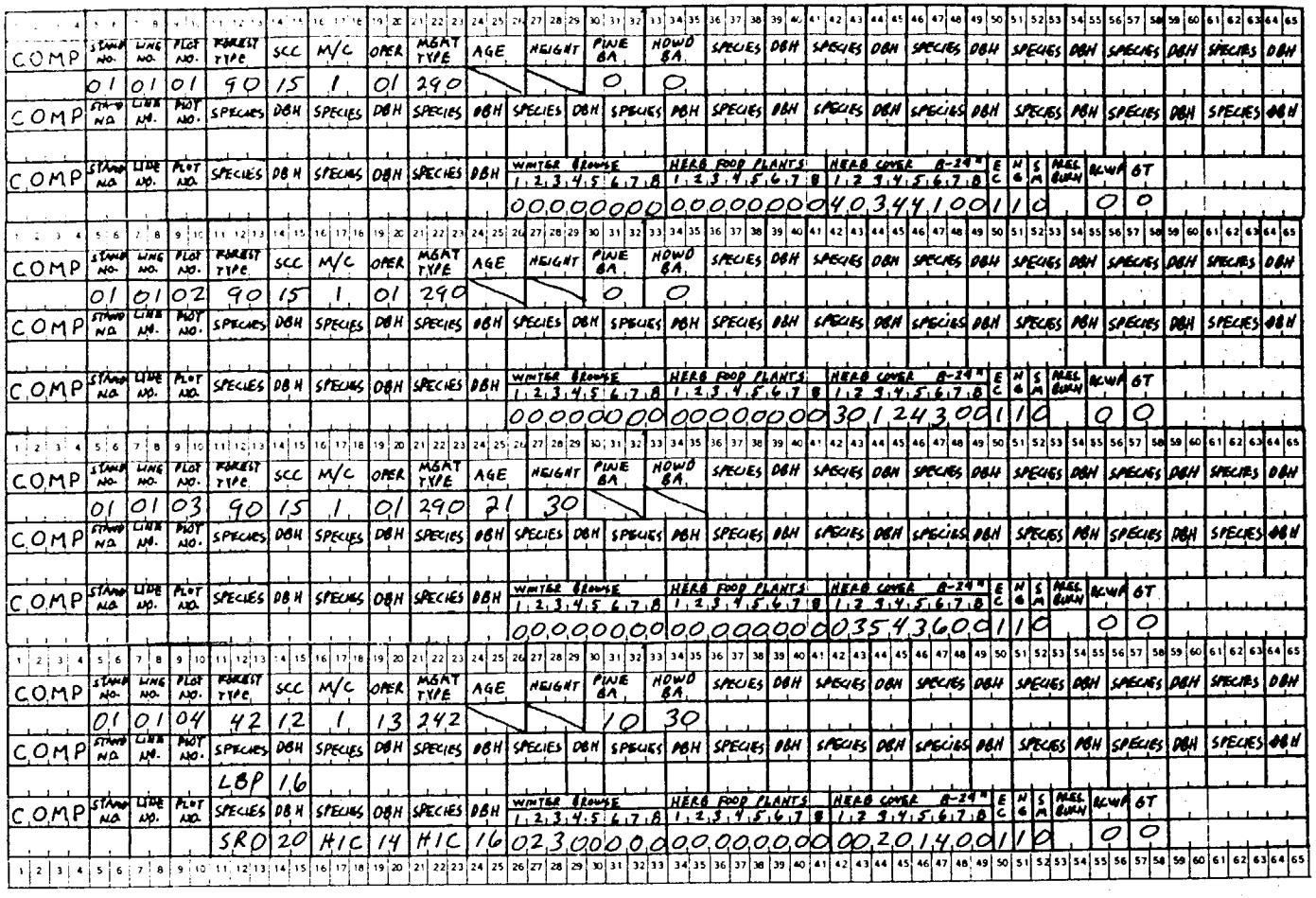


Figure C1. Data recording sheets

COMP	STAND NO	LINE NO	PLOT NO	FOREST TYPE	SCC	M/C	OPER	MGMT TYPE	AGE	HEIGHT	PINE BA	HDWD BA
:	:											

WINTER BROWSE	HERB FOOD	HERB COVER	EC	NG	SM	PRES BURN	RCWP	GT

SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH
SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH
SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH	SPECIES DBH

Figure C2. The field plot data entry screen

COMPARTMENT :ACREDD3.DBF:

STAND NUMBER : :	METHOD OF CUT	CULTURAL NEED 1
FOREST TYPE	OPERABILITY	DATE WORK 1
	AGE YEAR	
STAND CONDITION	MANAGEMENT TYPE	CULTURAL NEED 2
STAND GROSS ACRES	SITE INDEX	DATE WORK 2
		FY & REGN
STAND INCLUSION ACRES		PRESCRIPTION DATE
STAND NET ACRES		PHOTO NUMBER
		COUNTY

ARE ENTRIES CORRECT?

Figure C3. The compartment prescription summary entry screen

SIMPLE LISTING OF INPUT DATA FOR FIELDDAT FILE

COMP	STAND	LN	PN	FTP	SC	M/C	OP	MTP	AGE	HGT	PBA	HBA	WINTER	HERBFOOD	HERBCOVR	EC	NG	SM	PH	RC	GT
DD3	01		01	31	12	1	03	Z31			40		000000	000000	001212	1	0	1			
DD3	01		02	31	12	1	03	Z31			90		000000	000000	000000	1	0	1			
DD3	01		03	31	12	1	03	Z31			40		000000	000000	000000	1	0	1			
DD3	01		04	31	12	1	03	Z31			30	10	000000	000000	000000	1	0	1			
DD3	01		06	31	12	1	03	Z31			20	40	000000	000000	210020	1	0	1			
DD3	01		08	31	12	1	03	Z31			40	20	000000	000000	000000	1	0	1			

TOTAL LISTING OF SPECIES

SPECIES	DBH	COMP	STANDNO	LINENO	PLOTNO	TYPE	WOOD	COVER TYPE
LBP	18	DD3	01		01	PINE		NARROW
LBP	16	DD3	01		01	PINE		NARROW
LBP	14	DD3	01		01	PINE		NARROW
LBP	14	DD3	01		01	PINE		NARROW

COMPARTMENT PRESCRIPTION SUMMARY

STAND NO	FOREST TYPE	STAND COND	GROSS ACRES	INCLU ACRES	NET ACRES	MOC	OPER	AGE YEAR	MGNT TYPE	INDEX	CULT NEED 1	DATE WORK 1	CULT NEED 2	DATE WORK 2	FY & PRES REGN	DATE	GS HSI	BW HSI	WTD HSI	EWT HSI	ROMP REPRO HSI	ROMP FORAG HSI
1	31	12	175	0	175	1	04	1923	Z31	070	80	88	80	93		1984	0.06	0.11	0.02	0.26	0.53	0.76
2	25	12	86	0	86	1	04	1907	131	070	80	88	80	93		1984	0.00	0.00	0.00	0.04	0.00	0.00
3	31	12	26	0	26	1	04	1920	Z31	070	80	88	80	93		1984	0.00	0.11	0.33	0.22	0.55	0.81

Figure C4. Listings of the data for editing purposes

COMP	STANDNO	LINENO	PLOTNO	FORSTYPE	SCC	MC-	OPER	MGTTYPE	AGE	HEIGHT	PINEBA
DD3	40		01	31	12	1	03	Z31			040
DD3	40		02	31	12	1	03	Z31			090
DD3	40		03	31	12	1	03	Z31			040
DD3	40		04	31	12	1	03	Z31			030
DD3	40		05	31	12	1	03	Z31			020

BROWSE ||<0:>||COMPDD3 ||Rec: 4/54 || ||NumCaps

View and edit fields.

Figure C5. The plot data edit screen

SPECIES	DBH	COMP	STANDNO	LINENO	PLOTNO	TYPE	WOOD	COVER TYPE
LBP	18	DD3	01		01	PINE		NARROW
LBP	16	DD3	01		01	PINE		NARROW
LBP	14	DD3	01		01	PINE		NARROW
LBP	14	DD3	01		01	PINE		NARROW
LBP	16	DD3	01		02	PINE		NARROW
LBP	14	DD3	01		02	PINE		NARROW
LBP	10	DD3	01		02	PINE		NARROW
LBP	12	DD3	01		02	PINE		NARROW
LBP	10	DD3	01		02	PINE		NARROW
LBP	14	DD3	01		02	PINE		NARROW
LBP	16	DD3	01		02	PINE		NARROW
LBP	12	DD3	01		02	PINE		NARROW
LBP	14	DD3	01		02	PINE		NARROW

BROWSE ||<C:>||SPECDD3 ||Rec: 4/54 || ||NumCaps

View and edit fields

Figure C6. The species data edit screen

COMP	STANDNO	ERDOSNUMB	FORSTYPE	STANDCOND	GROSSACRE	INCLUACRE	NETACRES	MOC	OPER
DD3	01		31	12	175	0	175	1	04
DD3	02		25	12	86	0	86	1	04
DD3	03		31	12	26	0	26	1	04
DD3	04		31	12	18	0	18	1	04
DD3	05		25	12	18	1	17	1	13
DD3	06		90		110	0	110		
DD3	07		13	12	186	0	186	1	04
DD3	08		760		48	0	48		
DD3	09		31P	13	21	0	21	1	01
DD3	10		25	12	26	2	24	1	04
DD3	11		31P	13	51	0	51	1	01

BROWSE ||<C:>|| ||Rec: 4/54 || ||NumCaps

View and edit fields

Figure C7. The compartment summary edit screen

```
FORT BENNING RESOURCE MANAGEMENT

      W    WORD PROCESSING
      L    LANDMENU
      D    DBASE III+
      E    ERDAS
      C    CLIPPER

DATE  Mon 10-17-1988
TIME  9:07:33.40
YOU ARE IN THE DIRECTORY C:\
PLEASE ENTER A MSDOS COMMAND >
```

Figure C8. System menu

The system will load the dBASE III Plus software. The user will need to hit the <--/ enter key to assent to the license agreement. After the <--/ enter key has been hit, the system loads the necessary LANDMENU software. The user is presented with the opening menu (Figure C9).

```
                THE UNITED STATES ARMY

                  CORPS OF ENGINEERS
WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI

/-------------------------------------------------\
|              OPENING MENU                       |
|      (Version 1.1 - 5 July 1988)                |
|                                                 |
|  1  ENTER FIELD PLOT DATA                       |
|  2  ENTER COMPARTMENT SUMMARY INFORMATION       |
|  3  STAND DESIGNATION FROM PLOT DATA PROCEDURE  |
|  4  EDIT DATA FILES                             |
|  5  HSI & TIMBER COMPUTATIONS                   |
|  6  REPORTS                                     |
|  7  COMPARTMENT STATUS                          |
|  8  UTILITIES                                   |
|                                                 |
|  9  RETURN TO THE dBASE COMMAND SYSTEM          |
|  0  RETURN TO THE MSDOS OPERATING SYSTEM        |
\-------------------------------------------------/

                YOUR SELECTION PLEASE?
```

Figure C9. LANDMENU opening menu

5. To make a selection from any of the menus, the user enters the number or letter associated with each option.

Options Overview

6. The following section gives a brief description of each option available in the opening menu. Sections 2 through 9 provide details and instructions of use for each option.

7. Option 1 - ENTER FIELD PLOT DATA. Option 1 permits the keypunch operator to enter the field plot data. This consists of plot timber and wildlife summary data and specific tree species sampled. The first time a user enters data for a compartment, the system will take a few seconds to establish the necessary files. It is not necessary that plots be entered in numerical order; however, if a user starts to enter a plot, he should finish entering the entire plot. While a user is entering data for a plot, he is able to go back and make corrections on that plot. However, the user cannot go back and edit plots previously entered within this option; that operation must be done within the EDIT DATA FILES option (Option 4).

8. The user will not notice that the system stores the data in two separate files. The COMP???.DBF file stores the first line of the plot data (??? stands for the three-character compartment code). This line contains the stand, line, plot, timber, and wildlife data. The second file, SPEC???.DBF, stores the stand, line, plot, species, and diameter at breast height (dbh) values. These two files become important if the user desires to edit the plot data.

9. When the user is finished entering data, the system returns to the opening menu.

10. Option 2 - ENTER COMPARTMENT SUMMARY INFORMATION. Entering the compartment summary information requires the user to have completed the stand designation and stand digitizing procedures. Although Option 3 can help with the stand designation procedures, this activity has been performed more efficiently manually in the past. The user enters the data one stand at a time. The data will be stored in a file called ACRE???.DBF.

11. Option 3 - STAND DESIGNATION FROM PLOT DATA PROCEDURE. Generally, stands are identified and marked on plot sheets prior to data entry into Operation 1. Occasionally, stand designations need to be changed or when plots are not identified with a stand, this option permits the user to make these

entries or corrections. Plots must have a stand designation before the system will use them in the calculations.

12. Although the user could make these adjustments within the LANDMENU EDIT option, the user would need to make each plot record changed in the COMP???.DBF file match with each corresponding species record found in the SPEC???.DBF file. By using Option 3, the system will perform the matching process. In this option, all the user needs to do is enter the line and plot number of the plots to be assigned, and then enter the stand number.

13. The user is limited to assigning a stand number to 15 plots at a time. This is caused by the fact that only 15 plots can visually fit on the monitor at a time. If more than 15 plots are required, the user merely assigns the stand number to 15 plots at a time. Additional plots are entered by repeating the process.

14. The system warns the user if plots have been previously assigned stand numbers or if a stand number has been used previously. The user is able to make alternate selections or ignore the messages. Ignoring the message does not change stand designations previously made.

15. Option 4 - EDIT DATA FILES. Option 4 permits the user to edit three files. The first file is the COMP???.DBF file. This file contains the data found on the first line of field plot data. The only precaution is that if the stand, line, or plot numbers are changed, the user must remember to make the same changes in the SPEC???.DBF file. The second file that can be edited is the SPEC???.DBF file. This file contains the species and dbh data associated with the COMP???.DBF file. Once again, any changes in the stand, line, or plot numbers will have to match the data in the COMP???.DBF file. The third file is the compartment prescription summary file. Changes made in this file will not impact the other files until the calculations are run.

16. All editing is performed using the dBASE III Plus BROWSE command. Users should become familiar with how to operate in the BROWSE environment by referring to the dBASE III Plus manual. The following point is important! The user should never insert a record! Although dBASE III Plus permits insertion, it takes a long time to do this. If records need to be inserted or added to the file, these records should be appended to the end of the file, because the system does not need records typed in consecutive order to operate.

17. Option 5 - HIS & TIMBER COMPUTATIONS. This option requires very little user effort and computes wildlife habitat suitability indexes (HSI's), and timber information (board feet, cords, and basal area). The user is required to enter the three-digit compartment code and verify the system date.

18. Before the system begins the computations, it checks the wildlife and timber species data. The system identifies species it does not have in its data base and automatically assigns them a value of 'hardwood' as the tree type and 'standard' as the crown class (referred to as COVER TYPE in the files). The system will stop if there are any unrecognized species codes and ask the user if he would like to continue. If the user responds yes, the system will finish the process. If the user responds no, the system returns to the LANDMENU main menu. The user must go through the edit menu to edit the species data. Once corrections are made, the user should rerun the HSI calculation system.

19. Option 6 - REPORTS. The report option displays on the monitor any computer-generated reports; many of the reports can be sorted in a variety of ways and printed. Generally, the reports cover only one compartment. There is a timber and HSI report that gives summary totals for each compartment for the entire installation.

20. Option 7 - COMPARTMENT STATUS. This option lets the user keep track of the data collection and data entry for managing the project. The system updates information concerning data entry and the completion of computations. The user can also use this option to account for field data collection status.

21. Option 8 - UTILITIES. The utility option gives the user the capability to make backups of a compartment, LANDMENU software, or the total system.

22. Option 9 - RETURN TO THE DBASE COMMAND SYSTEM. For users who are comfortable and knowledgeable concerning the dBASE III Plus command language, this option permits access to this environment.

23. Option 0 - RETURN TO THE MS DOS OPERATING SYSTEM. Option 0 allows the user to exit the LANDMENU SYSTEM and return to MS DOS in the root directory.

PART II: ENTER FIELD PLOT DATA (OPENING MENU OPTION 1)

24. The user is presented with a menu after turning on the computer. This menu permits the user to access all available software located on the hard disk. To access the LANDMENU system, the user should hit the letter 'L' which corresponds to the LANDMENU option. The system will load the dBASE III Plus software. The user must hit the enter key to consent to the copyright notice. After doing so, the system will load the LANDMENU software. At this point, the user will be presented with the OPENING MENU (Figure C10).

THE UNITED STATES ARMY

CORPS OF ENGINEERS
WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI

```
/-----------------------------------------------\
|              OPENING MENU                     |
|      (Version 1.1 - 5 July 1988)              |
|                                               |
|   1  ENTER FIELD PLOT DATA                    |
|   2  ENTER COMPARTMENT SUMMARY INFORMATION    |
|   3  STAND DESIGNATION FROM PLOT DATA PROCEDURE |
|   4  EDIT DATA FILES                          |
|   5  HSI & TIMBER COMPUTATIONS                |
|   6  REPORTS                                  |
|   7  COMPARTMENT STATUS                       |
|   8  UTILITIES                                |
|                                               |
|   9  RETURN TO THE dBASE COMMAND SYSTEM       |
|   0  RETURN TO THE MSDOS OPERATING SYSTEM     |
\-----------------------------------------------/
```

YOUR SELECTION PLEASE?

Figure C10. The first menu the user will see once in the LANDMENU system

25. Choose Option 1 from the OPENING MENU to enter data collected from the field. The system will ask if this is a new compartment (Figure C11).

IS THIS A NEW COMPARTMENT YOU WANT TO CREATE (Y/N)?

Figure C11. Before entering data, the system will ask if the user is about to enter data for a new compartment

26. A new compartment is a compartment for which no data have been previously entered. If yes, the system will set up all necessary files. If no, the system locates the correct data file and permits the user to add data to the old file.

27. Before the user enters the three-character compartment code, the system displays the files currently existing on the hard disk (Figure C12). To open a new file or to enter data into an existing file, the user simply enters the three-character compartment code at the system prompt. The computer checks to make sure the file exists if entering data for a file previously created, or the system makes sure that the new file to be created is not already on the system.

```
THIS IS A LIST OF AVAILABLE COMPARTMENTS.
COMPDD3.DBF        COMPK20.DBF        COMP000.DBF

  70372 bytes in      3 files.
331776 bytes remaining on drive.

ENTER COMPARTMENT COMP      .DBF     (ENTER BLANK TO QUIT.)
```

Figure C12. Before entering the compartment code, the system displays the compartment files currently on the hard disk

28. After entering an acceptable compartment code, the data entry screen will be displayed (Figure C13). Here the user enters data as recorded by the data collectors in the field. Do not replace blanks with zeros (0). If the data collector left a field blank, enter a blank by hitting the space bar.

29. The user must enter the three-character compartment code for each data plot. As shown later, the user must enter a blank in the COMP field to tell the system that the user is finished entering plot data for now. After entering the compartment code, the remaining fields are displayed (Figure C14).

30. The user enters data from left to right in a data field. If a field is filled with data, the cursor automatically goes to the next field. If the field is not filled with data, the user must hit the enter key to get

```
COMP  STAND  LINE  PLOT  FOREST  SCC  M/C  OPER MGMT  AGE  HEIGHT  PINE HDWD
        NO    NO    NO    TYPE                  TYPE                 BA   BA

:   :

  WINTER      HERB        HERB        EC  NG   SM   PRES   RCWP          GT
  BROWSE      FOOD        COVER                     BURN

 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH

 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH

 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH
```

Figure C13. Data entry screen before any data entry. (Note the colons for compartment code)

```
COMP  STAND  LINE  PLOT  FOREST  SCC  M/C  OPER MGMT  AGE  HEIGHT  PINE HDWD
        NO    NO    NO    TYPE                  TYPE                 BA   BA

:DD3:  :  :  :  :  :  :  :  :  :  : :  : :  ::  : :  : :  :  :  ::  :

  WINTER      HERB        HERB        EC  NG   SM   PRES   RCWP          GT
  BROWSE      FOOD        COVER                     BURN

:      : :      : :      :  : : : :  : :  :  :  :  :      :  :

 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH

 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH
```

Figure C14. Portrayal of the screen after the three-character compartment code is entered. (Note the colons for the remaining data fields)

to the next field. When the top line of the data sheet has been entered, the SPECIES FIELD IS PRESENTED (Figure C15).

```
COMP  STAND  LINE  PLOT  FOREST  SCC  M/C  OPER MGMT  AGE  HEIGHT  PINE HDWD
       NO    NO    NO    TYPE                    TYPE                BA   BA

:DD3:  :01:  :01:  :01:  :230:  :01: :001: :01::180: :080: :020:  : 20:: 30:

  WINTER      HERB        HERB        EC  NG   SM   PRES   RCWP          GT
  BROWSE      FOOD        COVER                    BURN

:22223432: :11121112: :12345321:  :1: :C:  :1:   :01:   :01:          :01:

 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH
  :    :
 SPECIES DBH  SPECIES DBH  SPECIES DBH  SPECIES DBH SPECIES DBH  SPECIES DBH
```

Figure C15. Portrayal of screen after the top line from the data sheet is entered. (Note the colons for the first species)

31. As the user enters the three-character species code, the system will display the dbh field. With each dbh entered, the system will present the next species field. If all the species and dbh fields are filled in this screen, the system will go back to the beginning of this area and permit the user to continue entering additional species.

32. To tell the computer the user has completed entering a plot, the user must hit the return key when the system asks for the next species. A blank in the species field tells the computer that the data for the plot have been entered (Figure C16).

33. To tell the computer that the user wishes to cease entering data for this compartment, the user must enter a blank when the system requests the compartment code. This tells the system that the user wants to leave the field plot data entry routine.

34. The system will ask if the user has entered all the data for this compartment (Figure 17C). If the user enters yes 'Y', the system will update this fact in its compartment status file.

COMP	STAND NO	LINE NO	PLOT NO	FOREST TYPE	SCC	M/C	OPER	MGMT TYPE	AGE	HEIGHT	PINE BA	HDWD BA
:DD3:	:01:	:01:	:01:	:230:	:01:	:001:	:01:	:180:	:080:	:020:	: 20:	: 30:

WINTER BROWSE	HERB FOOD	HERB COVER	EC	NG	SM	PRES BURN	RCWP	GT
:22223432:	:11121112:	:12345321:	:1:	:0:	:1:	:01:	:01:	:01:

SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH
:LBP:	:10:	:LBP:	:20:	:WAO:	:10:	:WAO:	:16:	:WAO:	:08:	:	:
SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH
SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH	SPECIES	DBH

Figure C16. Portrayal of screen after completing a plot. The user entered a blank for the species field. (Note the blank colons under the COMP field.) The system is waiting for the user to enter the three-character compartment code for the next plot

Have you entered all data for this compartment (Y/N)? :N:

Figure C17. System questioning whether all data have been entered. If yes, the system updates the compartment status file

NOTE: It is possible to move the cursor backwards and make corrections. However, the user cannot return to change the compartment, species, or dbh fields. This is because the computer must do some processing when these fields are entered. Once the computer does processing, the field cannot be edited within this option. The user also cannot go back and make changes in the first two lines once the species have been entered. This is caused by the first two lines being stored in a file called COMP???.DBF and the species being stored in the SPEC???.DBF file. Although this is somewhat inconvenient, it is faster if the keypunch operator notes mistakes on the data sheets and continues entering data. The data can be edited more effectively and efficiently in the EDIT routine.

PART II: COMPARTMENT SUMMARY INFORMATION (OPENING MENU OPTION 2)

35. The user must select Option 2 from the opening menu to enter the compartment summary information. Before entering data into this option, the user should have completed the stand designation process and stand digitizing. Stand digitizing informs the user of the number of acres in each stand. Data are stored in a file called ACRE???.DBF.

36. After choosing Option 2 from the opening menu, the system questions whether this is the first time the compartment prescription summary data will be entered for this compartment (Figure C18). If yes, the system creates the appropriate file. If no, the system locates the file needed and permits the user to enter additional stands.

Is this the first time to enter Compartment Summary Data
in this Compartment (Y/N)?

Figure C18. This is what the user sees after choosing Option 2 from the opening menu

37. Figures C19 and C20 show the screens the user sees when entering data from a new compartment.

ACREDD3.DBF ACREALL.DBF ACRE000.DBF ACRETOTL.DBF

710286 bytes in 4 files.
331776 bytes remaining on drive.

Enter new compartment name (blank to quit): ACRE

Figure C19. This screen is presented when LANDMENU creates a new file

38. After the user enters the three-character compartment code, the system checks to make certain the file does not already exist (Figure C20).

```
ACREDD3.DBF        ACREALL.DBF        ACRE000.DBF        ACRETOTL.DBF

710286 bytes in      4 files.
331776 bytes remaining on drive.


        File already exists, try again or quit.

        Enter new compartment name (blank to quit): ACRE
```

Figure C20. If the user is creating a new file and enters a code for a compartment that already exists on the system, the message second from the bottom will appear

39. Figure C21 is the screen that appears when the user attempts to enter data into an existing file. The system will verify that the file exists.

```
 THIS IS A LIST OF AVAILABLE ACREAGE COMPARTMENT PRESCRIPTION FILES.
ACREDD3.DBF        ACREALL.DBF        ACRE000.DBF

695052 bytes in      3 files.
331776 bytes remaining on drive.


          ENTER FILE    ACRE  ???.DBF    (ENTER BLANK TO QUIT.)

SORRY, ACREAGE FILE DOES NOT EXIST.  TRY AGAIN.
```

Figure C21. Screen that appears when the user attempts to add stands to a file that does not exist

40. After entering an acceptable compartment code, the user is presented with the data entry screen (Figure C22). The screen is the same for both new and old compartments. The basic procedure is to fill in the blanks. After entering stand data the user is asked if the entries are correct. If the answer is "no," the user needs to re-enter the entire stand data. This takes only a few seconds. Answering "yes" permits the user to enter the next stand. When the user finishes entering all stands, the user enters nothing in the stand field and hits the Enter key. This informs the system that data entry has stopped and the user is returned to the opening menu. Figures C23 through C27 give examples of the process.

COMPARTMENT :ACREDD3.DBF:

STAND NUMBER	: :	METHOD OF CUT	CULTURAL NEED 1
FOREST TYPE		OPERABILITY	DATE WORK 1
		AGE YEAR	
STAND CONDITION		MANAGEMENT TYPE	CULTURAL NEED 2
STAND GROSS ACRES		SITE INDEX	DATE WORK 2
			FY & REGN
STAND INCLUSION ACRES			PRESCRIPTION DATE
STAND NET ACRES			PHOTO NUMBER
			COUNTY

ARE ENTRIES CORRECT?

Figure C22. Data entry screen that appears after an acceptable compartment code is entered

```
                    COMPARTMENT  :ACREDD3.DBF:

STAND                          METHOD                        CULTURAL
NUMBER          :01:           OF CUT          : :           NEED 1          :  :

FOREST                         OPERABILITY     :  :          DATE
TYPE            :   :                                        WORK 1          :  :
                               AGE YEAR        :    :
STAND                                                        CULTURAL
CONDITION       :  :           MANAGEMENT                    NEED 2          :  :
                               TYPE            :    :
STAND                                                        DATE
GROSS                          SITE INDEX      :  :          WORK 2          :  :
ACRES           : 0:
                                                             FY &
STAND                                                        REGN            :   :
INCLUSION
ACRES           : 0:                                         PRESCRIPTION
                                                             DATE            :    :
STAND                                                        PHOTO NUMBER    :     :
NET ACRES       : 0:                                         COUNTY          : :

                    ARE ENTRIES CORRECT? :N:
```

Figure C23. After the user enters the stand number, the system prepares itself for additional data. (Note the 0's in the first column that appear after the stand number is entered)

```
                    COMPARTMENT  :ACREDD3.DBF:

STAND                          METHOD                        CULTURAL
NUMBER          :01:           OF CUT          :1:           NEED 1          :  :

FOREST                         OPERABILITY     :2 :          DATE
TYPE            :230:                                        WORK 1          :  :
                               AGE YEAR        :1988:
STAND                                                        CULTURAL
CONDITION       :01:           MANAGEMENT                    NEED 2          :  :
                               TYPE            :180 :
STAND                                                        DATE
GROSS                          SITE INDEX      :01 :         WORK 2          :  :
ACRES           :100:
                                                             FY &
STAND                                                        REGN            :   :
INCLUSION
ACRES           :10:                                         PRESCRIPTION
                                                             DATE            :    :
STAND                                                        PHOTO NUMBER    :12345:
NET ACRES       : 90:                                        COUNTY          :C:

                    ARE ENTRIES CORRECT? :N:
```

Figure C24. Example of the data entered for one stand

```
                    COMPARTMENT  :ACREDD3.DBF:

STAND                    METHOD                   CULTURAL
NUMBER          :  :     OF CUT          :1:     NEED 1          :  :

FOREST                   OPERABILITY     :2 :    DATE
TYPE            :230:                            WORK 1          :  :
                         AGE YEAR        :1988:
STAND                                            CULTURAL
CONDITION       :01:     MANAGEMENT              NEED 2          :  :
                         TYPE            :180 :
STAND                                            DATE
GROSS                    SITE INDEX      :01 :   WORK 2          :  :
ACRES           :100:
                                                 FY &
STAND                                            REGN            :  :
INCLUSION
ACRES           :10:                             PRESCRIPTION
                                                 DATE            :  :
STAND                                            PHOTO NUMBER    :12345:
NET ACRES       : 90:                            COUNTY          :C:

                    ARE ENTRIES CORRECT? :N:
```

Figure C25. Here, the user has typed "n" for no, when responding to the question "ARE FNTRIES CORRECT?". The system has blanked out the stand number field for the user to re-enter

```
                    COMPARTMENT  :ACREDD3.DBF:

STAND                    METHOD                   CULTURAL
NUMBER          :02:     OF CUT          :  :    NEED 1          :  :

FOREST                   OPERABILITY     :  :    DATE
TYPE            :  :                             WORK 1          :  :
                         AGE YEAR        :  :
STAND                                            CULTURAL
CONDITION       :  :     MANAGEMENT              NEED 2          :  :
                         TYPE            :  :
STAND                                            DATE
GROSS                    SITE INDEX      :  :    WORK 2          :  :
ACRES           :  0:
                                                 FY &
STAND                                            REGN            :  :
INCLUSION
ACRES           : 0:                             PRESCRIPTION
                                                 DATE            :  :
STAND                                            PHOTO NUMBER    :  :
NET ACRES       :  0:                            COUNTY          :  :

                    ARE ENTRIES CORRECT? :N:
```

Figure C26. Once the stand number is entered, the system will reset itself. (Note the 0's in Column 1 again)

COMPARTMENT :ACREDD3.DBF:

STAND NUMBER	: :	METHOD OF CUT	:2:	CULTURAL NEED 1	:11:
FOREST TYPE	:230:	OPERABILITY	:2 :	DATE WORK 1	:92:
		AGE YEAR	:1950:		
STAND CONDITION	:01:	MANAGEMENT TYPE	:01 :	CULTURAL NEED 2	:22:
STAND GROSS ACRES	: 60:	SITE INDEX	:01 :	DATE WORK 2	:93:
				FY & REGN	:111:
STAND INCLUSION ACRES	: 5:			PRESCRIPTION DATE	:1989:
STAND NET ACRES	: 55:			PHOTO NUMBER	:12345:
				COUNTY	:C:

ARE ENTRIES CORRECT? :Y:

Figure C27. Here, the user has typed "Y" to indicate that entries are correct. The stand is saved and the system is now ready for the next stand. (Note the blank field for the stand number.) When the stand number is entered, the system will reset itself and look like Figure C9

41. Once again, remember, DO NOT PLACE ZEROS (0) WHERE THE DATA SHEETS HAVE BLANKS. All information entered in this option can be edited in the editing routine.

PART IV: STAND DESIGNATION FROM PLOT DATA PROCEDURE (OPENING MENU OPTION 3)

42. Choosing Option 3 from the opening menu permits the user to make changes in plot designations or to initially designate stands not previously identified. Normally this is accomplished manually and recorded on the data sheets prior to data entry, but this option allows for amendments.

43. Although the user is capable of designating stands in the edit routine, the user must be certain that both COMP???.DBF AND SPEC???.DBF files match. The compartment file contains the top line for each plot from the data sheet while the species file contains the tree species and dbh values. In the edit routine the user must edit both files. In this routine, the user selects the plot from the compartment file and the system matches the compartment plots with the species plots.

44. After choosing Option 3 from the opening menu, the user is presented with the compartment selection screen (Figure C28). Here, the user enters the three-character compartment code.

```
 THIS IS A LIST OF AVAILABLE COMPARTMENTS.
Volume in drive C has no label
Directory of  C:\LANDMENU

COMPDD3  DBF     COMPK20  DBF     COMP000  DBF     COMPSTAT DBF     COMPFORC DBF
      5 File(s)     331776 bytes free


ENTER COMPARTMENT COMP      .DBF     (ENTER BLANK TO QUIT.)
```

Figure C28. Compartment selection screen from Option 3

45. After entering an acceptable compartment code, the user sees the initial plot selection screen (Figure C29). To select a plot, the user enters the line and plot number. The user must enter the line and plot exactly as they are stored in the file. Thus, if the line and plot are stored as : 1: : 3:, the user must enter the data like that and not :01: :03: or :1 : :3 :.

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA

ENTER LINE : : ENTER PLOT : : (15 MAX ENTRIES. ENTER BLANK WHEN FINISHED.)

Figure C29. Initial line and plot selection screen

46. The system checks various items before displaying the plot on the screen. First, it makes certain that the line and plot entered are in the compartment. If not, the system will print a message accordingly (Figure C30). If the line and plot selected already are assigned a stand number, the user is informed of this fact (Figure C31).

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	

ENTER LINE : : ENTER PLOT : : (15 MAX ENTRIES. ENTER BLANK WHEN FINISHED.)
LINE AND PLOT COMBINATION DOES NOT EXIST IN THIS FILE. TRY AGAIN.

Figure C30. Message when line and plot selected cannot be found in the file

47. If the line and plot have already been assigned a stand number, the system asks the user if the line and plot should still be selected. A "Yes" response includes it in the current selections. No permanent change is made until later. A "No" response gives the user the opportunity to select another line and plot.

48. Once a plot is accepted, the system displays the plot under the heading line. To stop entering plots, the user enters blanks in both line and

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	

THIS LINE AND PLOT COMBINATION ALREADY HAS A STAND NUMBER - :01:
DO YOU WANT TO STILL USE THIS LINE AND PLOT (Y/N)? :N:
ENTER LINE :02: ENTER PLOT :05: (15 MAX ENTRIES. ENTER BLANK WHEN FINISHED.)
LINE AND PLOT COMBINATION DOES NOT EXIST IN THIS FILE. TRY AGAIN.

Figure C31. Message when line and plot are already assigned a stand number

plot fields. At this point, the system computes averages for the age, height, pine, and hardwood basal fields. The averages are computed on only the plots that have been data entered in the field of interest. The averages are shown at the bottom of the list (Figure 32C).

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
4	03	01	31	12	1	03	231			30	10
5	02	01	31	12	1	03	231			40	20
						AVERAGES				48	15

ARE YOU TOTALLY SATISFIED WITH THESE LINES AND PLOTS IN ORDER TO MAKE THEM INTO A STAND (Y/N)? :N:

Figure C32. Screen when user has completed initial line and plot selections

49. The user is asked if the grouping is acceptable for assigning a stand. If "Yes," the system asks for a stand designation and assigns the stand numbers to plots in both files. If no, the user is asked if he would like to delete and/or add plots. After a group of deletions and additions, the user is again asked if the listing is acceptable for plot assignment. This process continues until the user is satisfied.

50. First, the user is asked if he desires to delete any of the selections (Figure C33). If "Yes," the user is presented with the deletion line and plot selection screen (Figure C34). To delete a line and plot, the user selects the number (#) on the screen. Thus, if the user wants to delete the

line and plot under # 4, the user enters 4. The system blanks out the line number selected. The user can continue deleting records in this fashion. When finished, the user enters a blank. The system then asks if there are any additions (Figure C35).

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
4	03	01	31	12	1	03	231			30	10
5	02	01	31	12	1	03	231			40	20
						AVERAGES				48	15

DO YOU WANT TO DELETE ANY PLOTS (Y/N)? :Y:

Figure C33. Deletion screen

51. If the user desires to add lines and plots, the user enters "Yes." Answering "Yes" gives the user the line and plot addition screen (Figure C36). Here, the user enters the line and plot somewhat differently, merely to differentiate the adding of lines and plots from the initial selection. The user enters the line and plot in the same field. However, the same rule applies; the line and plot must be entered in the same format as that stored in the file.

52. Additional lines and plots are first inserted into slots vacated by lines and plots that were deleted. If there are no vacant slots, the system adds the lines and plots to the bottom of the screen. When finished adding lines and plots, the user enters a blank in the line and plot field. The

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
4	03	01	31	12	1	03	231			30	10
5	02	01	31	12	1	03	231			40	20
						AVERAGES				48	15

WHICH PLOT # ON THE SCREEN DO YOU WANT TO DELETE ? : 0:

Figure C34. Deletion line and plot entry screen

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
5	02	01	31	12	1	03	231			40	20
						AVERAGES				60	30

DO YOU WANT TO ADD MORE LINES (Y/N)? :Y:

Figure C35. Addition screen

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
5	02	01	31	12	1	03	231			40	20
						AVERAGES				60	30

ENTER LINE AND PLOT :LLPP: :....:(15 MAX ENTRIES.)

Figure C36. The line and plot addition screen

system then re-computes the averages and once again asks if the user is satisfied with the grouping (Figure C32). The deletion/addition process continues until the users responds to this question with "Yes."

53. Once the user is satisfied with his/her selection, the system asks the user for a stand number (Figure C37). The user enters a two-digit stand number. After the stand number is entered, the system verifies that the stand number does not already exist. If it does not, the system continues with processing. If the stand number selected by the user has already been assigned to plots, the user is notified of this and has the option to choose a different stand number or to ignore the message and accept this stand number for the plots selected (Figure C38).

54. Once the stand number is accepted, the system asks if the user desires a printed copy of the lines and plots selected (Figure C39). In order to get a printed copy, the user selects the MS DOS screen print routine SHIFT PRINT SCREEN. The user holds down the shift key and strikes the print screen key. This prints a copy of the screen. When ready, the user strikes the

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
4	02	02	31	12	1	03	231			20	40
5	02	01	31	12	1	03	231			40	20
6	03	03	31	12	1	03	231				
						AVERAGES				46	30

ENTER THE STAND NUMBER :00:

Figure C37. Screen for requesting the stand number

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
4	02	02	31	12	1	03	231			20	40
5	02	01	31	12	1	03	231			40	20
6	03	03	31	12	1	03	231				
						AVERAGES				46	30

THIS STAND NUMBER HAS ALREADY BEEN USED IN THE FILE.
DO YOU WANT TO KEEP YOUR STAND NUMBER SELECTION (Y/N)? :N:
ENTER THE STAND NUMBER :01:
CHECKING TO MAKE SURE THIS STAND NUMBER DOES NOT ALREADY EXIST.

Figure C38. Message received if stand number already exists on the system

#	LN	PT	FTP	SCC	M/C	OPER	MTP	AGE	HT	PBA	HBA
1	01	01	31	12	1	03	231			40	
2	02	05	31	12	1	03	231			90	
3	01	02	31	12	1	03	231			40	
4	02	02	31	12	1	03	231			20	40
5	02	01	31	12	1	03	231			40	20
6	03	03	31	12	1	03	231				
						AVERAGES				46	30

IF YOU WOULD LIKE A PRINT OUT AND YOU HAVE AN IBM COMPATIBLE,
HIT THE SHIFT KEY AND THE PRTSC KEY AT THE SAME TIME.
HIT THE RETURN KEY WHEN FINISHED LOOKING AT SCREEN. : :

Figure C39. Screen with option to obtain a hard copy of the lines and plots

NOTE: ONLY 15 PLOTS CAN BE ASSIGNED AT ONE TIME. THIS IS CAUSED BY SCREEN LIMITATIONS. IF THE STAND HAS MORE THAN 15 PLOTS, THE USER SHOULD ASSIGN 15 PLOTS AT A TIME UNTIL FINISHED.

return key and the system allocates the stand number to the plots in both the compartment and species files.

55. After an acceptable stand number is entered, the system updates both the compartment and species files (Figure C40). When finished updating, the system informs the user as shown in Figure C41.

SPECIES STAND INFORMATION UPDATE PROGRAM

LAST STAND, LINE AND PLOT TO UPDATE - 07 12

NOW WORKING ON STAND NUMBER 01

NOW WORKING ON LINE NUMBER
NOW WORKING ON PLOT NUMBER 10

Figure C40. Update status screen

SPECIES FILE UPDATE COMPLETE. HIT RETURN KEY.
Press any key to continue...

Figure C41. Message that informs user when updating is complete

PART V: EDITING RECORDS (OPENING MENU OPTION 4)

56. The LANDMENU System uses the dBASE III Plus BROWSE command to permit users to edit records. Because of the numerous reasons for a user to edit data, and because so much data is not unique and thus cannot be searched directly, the BROWSE command is the best method for editing. The user may need to do extensive searching to find the desired records, but a viable alternative does not appear to exist.

57. Before editing, the user should print the records, mark corrections on paper, and then edit on the computer. After the first edit, records should be printed again, checked to ensure corrections were properly made, and then edit again on the computer. A third printout should be made just to make a final check. If there are more errors, the user should correct on the computer and make notes on the printout. It is not reasonable to reprint the file again.

Running the Edit Routine

58. From the opening menu, the user should choose Option 4 "EDIT DATA FILES." Once this option is selected, the edit menu will appear on the screen (Figure C42).

EDIT MENU

1 EDIT COMPARTMENT DATA
2 EDIT SPECIES DATA
3 EDIT COMPARTMENT PRESCRIPTION SUMMARY

9 RETURN TO OPENING MENU

YOUR SELECTION PLEASE?

Figure C42. Edit menu

59. The three files that can be edited are compartment (COMP???), species (SPEC???), and the compartment prescription summary file (ACRE???). The compartment and species files are generated from the plot data entry sheets. The compartment file consists of plot timber totals and wildlife data (top line of data sheet for each plot). The species file consists of the sampled trees for each plot. The compartment prescription file consists of the compartment summary information entered under Option 2 of the main menu.

60. All editing occurs in the same manner. As an example, the compartment file will be edited. To edit the compartment file, the user should choose Option 1 from the edit menu. After choosing Option 1, the user will see the screen shown in Figure C43.

```
THIS IS A LIST OF AVAILABLE COMPARTMENTS.
COMPDD3.DBF        COMPK20.DBF        COMP000.DBF

70458 bytes in     3 files.
337920 bytes remaining on drive.


ENTER COMPARTMENT COMP      .DBF    (ENTER BLANK TO QUIT.)
```

Figure C43. After choosing an edit option, the system will display the available files that exist on the hard disk

61. Note that the three-character compartment codes are preceded by the letters COMP representing a compartment file. The user should not be concerned if there are extra compartments like COMP000 or COMPHSI, since these files are used in the programs.

62. The user should enter the three-character compartment code. If the user wants to stop, the Enter key can be hit before entering a code. The system checks to make certain the code entered is acceptable. Once an acceptable compartment code is entered, the user will see the screen shown in Figure C44. Users familiar with dBASE III Plus need not read this message. It explains to the user how dBASE III Plus deletes records and how to add records if they were originally missed.

```
TO DELETE RECORDS, PLACE CURSOR ANYWHERE ON THE RECORD AND HIT
     Ctrl U.  THE RECORD WILL REMAIN ON THE SCREEN UNTIL FINISHED.
TO ADD RECORDS, HIT THE FUNCTION KEY (F10), THEN HIT THE RETURN
     OR ENTER KEY.  THIS WILL PLACE YOU AT THE END OF THE FILE.
     HIT THE DOWN ARROW.  AT THE BOTTOM OF THE SCREEN YOU WILL
     BE ASKED IF YOU WISH TO ADD RECORDS.  SAY YES (Y).  YOU
     MAY NOW ENTER RECORDS.
WHEN FINISHED EDITING, HIT Ctrl End (found on the numeric 1).
     ALL BLANK LINES AND DELETED RECORDS WILL BE REMOVED FROM
     THE FILE.  THE FILE WILL ALSO BE SORTED BY LINE AND PLOT.
Press any key to continue...
```

Figure C44. Message before editing

Explanation of Message

63. When a record needs to be deleted, dBASE does not physically delete the record. To delete the record, the user places the cursor on the record that needs to be deleted. Then the user hits CTRL U. The record will not disappear from the screen. All dBASE will do at this time is mark the record for deletion. dBASE will place DEL at the bottom of the screen (an example later will show this). When the user has completely finished editing the program, dBASE III physically deletes the record from the file.

64. If the user must add records, this should be done by appending them at the end of the file. To quickly go to the end of the file, the user may hit the F10 key. A menu will appear at the top of the screen. If the user hits the Enter key, the system will place the user at the last record in the file. The user should then hit the down arrow key (↓) to go below the last record. The system will ask if the user wants to enter new records. The user should respond with a yes by typing a "Y." The user is now able to enter as many new records as needed.

65. When finished editing/entering/deleting records, the user should hit CTRL END. This will terminate the editing routine and record any necessary changes. The entire message is used as a reminder for novices. When finished reading, the user should "Press any key to continue...." After experience is gained, the user should hit either the space bar or the enter key to skip over the message.

Editing

66. After hitting any key, the user will see the dBASE III BROWSE system with the data to be edited (Figure C45). At the top of the screen, the user will see the editing commands. The cursor options permit the user to move the cursor. The left and right arrows move the cursor left and right one typewritten character. The up and down arrows move the cursor up or down one record. Each line is considered a record and each column is considered a field. To go all the way to the left, the HOME key is hit. To move all the way to the right, the END key is hit. To see the next list of records, the user hits PgDn for page down. To go backwards, or to see the previous records, the user hits PgUp.

```
/-------------------------------------------------------------------------\
| CURSOR     <-- -->  |           UP   DOWN |    DELETE  | Insert Mode:  Ins |
|  Char:         →    | Record:    ↑     ↓  | Char:   Del | Exit:        ^End |
|  Field:  Home  End   |  Page:    PgUp  PgDn |  Field:  ^Y | Abort:        Esc |
|  Pan:      ^   ^→    | Help:     F1         | Record: ^U  | Set Options: ^Home |
\-------------------------------------------------------------------------/

COMP  STAHDNO  LINENO  PLOTNO  FORSTYPE  SCC  MC-  OPER  MGTTYPE  AGE  HEIGHT  PINEBA
DD3   40               01                                                       020
DD3   40               02                                                       050
DD3   40               03                                                       060
DD3   40               04                                                       010
DD3   40               05
DD3   40               06                                                       090
DD3   40               07                                                       040


BROWSE          ||<D:>||COMPDD3              ||Rec: 4/54            ||   Del||    Caps

                        View and edit fields.
```

Figure C45. dBASE III Plus Browse system screen

67. Note that PINEBA is the last field of the record shown on the screen in Figure C45. This is not the last field in the record. The other fields are conceptually off the screen to the right. To see and edit these and other fields, the user must pan left or right. To pan right, the user should hold the control key and hit the right arrow. Each time the user hits the right arrow, fields will move from right to left. The fields on the left

of the screen move left and off the screen. The fields on the right will appear on the right side of the screen. The field will not be visible unless sufficient space is available for the entire field to appear on the screen. Thus, sometimes the user must hit the CTRL right arrow several times before a field appears. Figure C46 shows a case in which a user hit the CTRL right arrow three times: COMP, STANDNO, and LINENO no longer appear on the screen; HDWD, WINTERBRW, and HERBFOOD have appeared.

```
/-------------------------------------------------------------------------\
| CURSOR      <-- -->  |            UP   DOWN |    DELETE   | Insert Mode: Ins |
|  Char:          -->  | Record:     ↑     ↓ | Char:   Del | Exit:        ^End |
|  Field:  Home   End  |  Page:    PgUp  PgDn |  Field:  ^Y | Abort:       Esc |
|  Pan:      ^    ^-->  | Help:     F1       | Record: ^U  | Set Options: ^Home |
\-------------------------------------------------------------------------/

PLOTNO  FORSTYPE  SCC  MC-  OPER  MGTTYPE  AGE  HEIGHT  PINEBA  HDWD  WINTERBRW  HERBFOOD
01                                                       020     080   010302     000000
02                                                       050     080   101000     000000
03                                                       060     060   021000     000000
04                                                       010     070   300000     100000
05                                                               120   111401     001000
06                                                       090     040   131101     000000
07                                                       040     090   000000     001000
```

Figure C46. The BROWSE screen with fields pulled from the right

68. The next screen (Figure C47) shows the user having panned back to the left as once again the compartment field shows. Note the line near the

```
/-------------------------------------------------------------------------\
| CURSOR      <-- -->  |            UP   DOWN |    DELETE   | Insert Mode: Ins |
|  Char:          -->  | Record:     ↑     ↓ | Char:   Del | Exit:        ^End |
|  Field:  Home   End  |  Page:    PgUp  PgDn |  Field:  ^Y | Abort:       Esc |
|  Pan:      ^    ^-->  | Help:     F1       | Record: ^U  | Set Options: ^Home |
\-------------------------------------------------------------------------/

COMP  STANDNO  LINENO  PLOTNO  FORSTYPE  SCC  MC-  OPER  MGTTYPE  AGE  HEIGHT  PINEBA
DD3   40               01                                                       020
DD3   40               02                                                       050
DD3   40               03                                                       060
DD3   40               04                                                       010
DD3   40               05
DD3   40               06                                                       090
DD3   40               07                                                       040

BROWSE          ||<D:>||COMPDD3              ||Rec: 4/54            ||   Del||    Caps

                          View and edit fields.
```

Figure C47. Status line screen

bottom that starts with "BROWSE." This is called the status line. It informs the user that he is in the browse command, is using the data file COMPDD3, the cursor is on record number 4 of 54 total records and the DEL informs the user that the 4th record is marked in the data base for deletion. As stated earlier, the record will not be physically removed until the user finishes editing. To restore the record, the user would only need to hit CTRL U again. CTRL U is called a toggle: the same command deletes and restores the records.

69. The next screen includes the insert key in the "on" position (Figure C48, bottom right). Note that the status line where the DEL is located now says "InsDel." The Ins means that the insert function is now on. To turn the Ins function on and off, hit the Ins key on the computer. Similar messages will occur when the caps lock is on.

```
/-------------------------------------------------------------------------\
| CURSOR     <-- --> |          UP   DOWN |    DELETE  | Insert Mode:  Ins |
|  Char:         --> | Record:    ↑    ↓  | Char:   Del | Exit:        ^End |
|  Field:  Home  End | Page:    PgUp  PgDn | Field:  ^Y | Abort:        Esc |
|  Pan:     ^  ^---> | Help:    F1         | Record: ^U | Set Options: ^Home |
\-------------------------------------------------------------------------/

COMP  STANDNO  LINENO  PLOTNO  FORSTYPE  SCC  MC-  OPER  MGTTYPE  AGE  HEIGHT  PINEBA
DD3   40               01                                                       020
DD3   40               02                                                       050
DD3   40               03                                                       060
DD3   40               04                                                       010
DD3   40               05
DD3   40               06                                                       090
DD3   40               07                                                       040

BROWSE          ||<D:>||COMPDD3              ||Rec: 4/54            ||InsDel||    Caps

                          View and edit fields.
```

Figure C48. Status line showing insert, delete, and caps lock on

70. When finished editing, hit CTRL END. This will save the corrections, remove blank and deleted records, and return the user to the opening menu.

PART VI: HIS AND TIMBER CALCULATIONS (OPENING MENU OPTION 5)

71. Choosing Option 5 from the opening menu permits the user to run the HSI and timber calculation programs. Before starting this process, the user should have entered and edited all field data, determined stand designations, digitized stands, entered and edited the compartment prescription summary, and made two floppy disk backups.

72. The system first attempts to use data files found on the hard disk. If the files are not on the hard disk, the system checks the floppy disk in drive B. When the system is finished processing, all data files are updated onto the floppy disk. Thus, even if data files are stored on the hard disk, the user must have a disk in drive B.

73. After choosing Option 5 and inserting the floppy disk in drive B, the system requests the user to enter the three-character compartment code (Figure C49).

```
                COMPARTMENTS ON THE HARD DISK.
Volume in drive C is WORK
Directory of  C:\LANDMENU

COMPDD3  DBF     COMP000  DBF
        2 File(s)     983040 bytes free


                COMPARTMENTS ON THE 360K FLOPPY DISK.
Volume in drive B has no label
Directory of  B:\

File not found


     ENTER COMPARTMENT COMP      .DBF     (ENTER BLANK TO QUIT.)
```

Figure C49. Request for compartment code

74. Once an acceptable code is entered, the system loads all necessary files onto the hard disk if they do not exist on the hard disk. Following this, the system requests that the user verify the current date, as some calculations access the system date (Figure C50). If the date is correct, the

```
Enter the current date for Red-Cockaded Woodpecker HSIs
Current date is Tue  3-21-1989
Enter new date (mm-dd-yy):
```

Figure C50. System requesting user to verify current date

user can hit the Enter key. Otherwise, the user must enter the date in the format MM/DD/YY. The day of the week should not be entered.

75. After verifying the date, the system checks the species file for invalid codes. Any codes not identified are assigned a "hardwood" wood type and a "standard" cover type. The system prints these species (Figure C51) and when finished, asks the user if the system should continue processing or stop, to permit the user to edit the listed species (Figure C52). If the user is not satisfied that the unidentified species should be listed as "hardwood - standard," the user should answer "NO," thus stopping the process. The user can then go the the EDIT routine, make corrections, and rerun the HSI and timber calculation routines.

```
173 WA0 04 HARDWOOD STANDARD
185 WA0 04 HARDWOOD STANDARD
189 WA0 04 HARDWOOD STANDARD
198 WA0 04 HARDWOOD STANDARD
211 WA0 04 HARDWOOD STANDARD
245 WA0 04 HARDWOOD STANDARD
```

Figure C51. Sample listing of species that were not identified by the computer program

```
CHECK DEFAULT LISTING.  SHOULD I CONTINUE (Y/N)?  :Y:
```

Figure C52. System message allowing user to let the system continue processing or edit the species records

76. If the system is permitted to continue processing, messages appear on the screen to keep the user informed of the progress (Figure C52). The entire process can take from 15 to 120 min depending on the number of species recorded. It is recommended that the user turn down the monitor brightness

Now determining the number of plots in each stand.

Now checking the tree species codes.

Now performing the first set of wildlife indices.

Now performing the second set of wildlife indices.

Now performing the wildlife average index calculations.

Figure C53. Messages displayed while the system is operating

and then periodically turn it up to check on the processing status. When finished processing, the system returns to the opening menu.

77. Output from the calculations is stored in four files. All HSI's for each stand are stored in the HSI???.DBF file. The overall HSI value for each stand and timber volumes for the stand are stored in the ACRE???.DBF files. The stand HSI and timber data for all compartments are stored in a file called ACRETOTL.DBF. A single HSI value for each animal and timber totals covering the entire compartment are stored in a file called HSISCOMP.DBF. The HSISCOMP.DBF file is also the file used to generate the HSI values used in the GIS system. The user may generate a variety of reports from these files by selecting the report menu option from the opening menu.

PART VII: REPORT MENU (OPENING MENU OPTION 6)

78. Choosing Option 6 from the opening menu provides the user with several report options. Figure C54 shows the report menu. The reports are in four areas. Section one, edit listings, offers printouts of data entered by the operator and is useful for editing purposes. Section two, compartment information, gives a listing of the compartment prescription summary information and gives totals for timber and wildlife for each compartment. Section three, timber information, offers reports related to timber and is available by stand or by compartment. Section four, wildlife information, presents information related to wildlife habitat suitability; details by animal species and stand are available within this section. Most reports can be shown on the screen or printer. In many cases, a variety of sort options are available. Sample printouts are included in Tab 1.

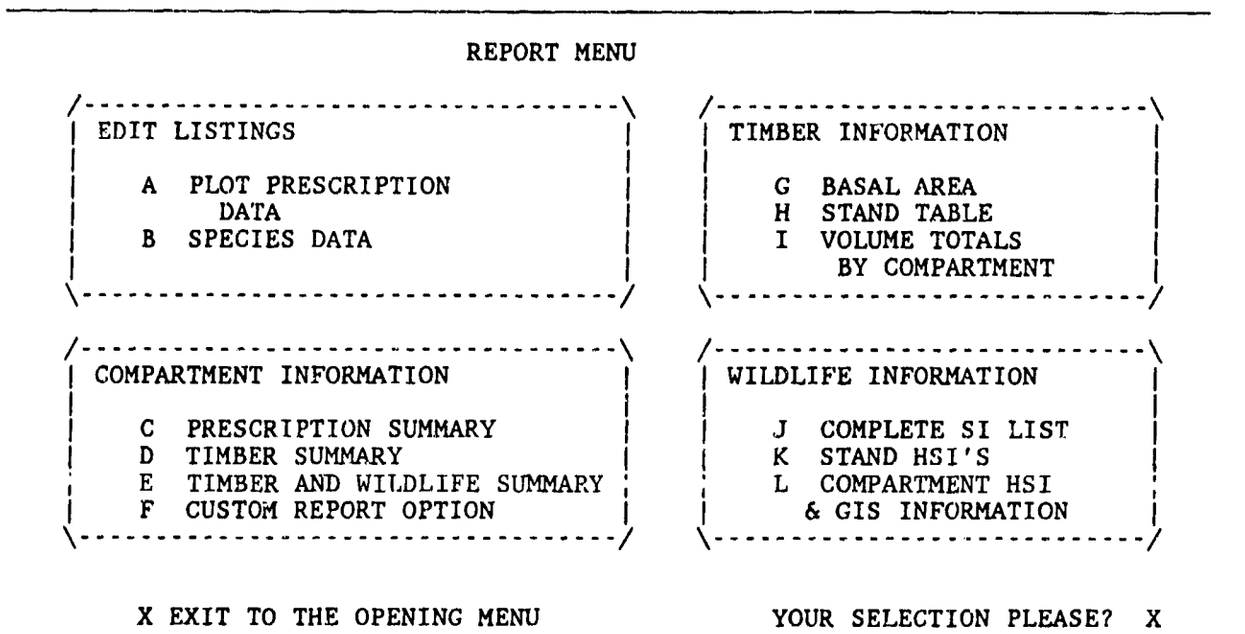


Figure C54. Report menu

79. The edit listings section permits the user to list the plot data-entered. Option A, plot description data, lists the data stored in the COMP file, the first line on the data plot sheets. Option B, species data, lists the data stored in the species file, the tree species, and dbh values. Each file can be listed on the screen or the printer. The user is also

permitted to have the list sorted in one of several ways (Figure C55). It is recommended that if the list is to be used for editing, the printout be made in the "as entered" option. This option lists data in the order they were entered by the operator. It is the easiest list to edit since this is the order in which the edit routine presents the data.

```
        COMPARTMENT
SORT SELECTION MENU

1  AS ENTERED
2  BY STAND, LINE, AND PLOT
3  BY FOREST TYPE
4  BY AGE
5  BY HEIGHT
6  BY PINE BASAL AREA
7  BY HARDWOOD BASAL AREA
YOUR SELECTION PLEASE? : :
```

```
          SPECIES
SORT SELECTION MENU

1  AS ENTERED
2  BY SPECIES
3  BY STAND, LINE AND PLOT
4  BY TYPE OF WOOD

YOUR SELECTION PLEASE?  : :
```

Figure C55. Compartment and species sort menus

80. The second section is compartment information. Option C lists the compartment prescription summary data. Because the length of each stand record does not permit the information to fit on the screen, this list is always printed. It prints in stand order.

81. Section three contains timber information. Options D and E give timber information by stands. Numerous reports are available (Figure C56), sorted by the user's discretion (Figure C57). Option F gives complete timber records sorted alphabetically by compartment.

82. The fourth section presents wildlife information. Option G gives a complete listing of HSI's to include each suitability index for each animal species by stand. Option H gives only the final HSI value for each species within a stand. Option I gives the HSI value, weighted by acreage for each species, by compartment. The wildlife information reports are listed by stand number or by alphabetical listing of compartment.

```
                        STAND TIMBER REPORT MENU

REPORT FORMAT 1:          STAND      TOTAL SAMPLED     BASAL AREA
                                          TREES         PER ACRE

YOU MAY SELECT ONLY          1  LIST TOTAL STAND DATA
ONE TREE TYPE FOR            2  LIST PINE DATA
THIS REPORT FORMAT.          3  LIST OAK DATA
                             4  LIST HICKORY DATA
                             5  LIST HARD MAST DATA
                             6  LIST HARD WOOD DATA
                             7  LIST NONCLASSIFIED DATA

REPORT FORMAT 2: PINE  OAK  HICKORY  HARDMAST  HARD WOOD  OTHER  STAND

                             8  TOTAL SAMPLED TREES
                             9  BASAL AREA PER ACRE

                             0  RETURN TO REPORT MENU

                          YOUR SELECTION PLEASE?          0
```

```
                    BOARD FEET AND CORDS
                    SORT SELECTION MENU


                 0  RETURN TO REPORT MENU
                 1  AS GENERATED BY COMPUTER
                 2  BY STAND
                 3  BY STAND AND TYPE OF WOOD
                 4  BY CORDS
                 5  BY BOARD FEET
                 6  BY DBH CLASS
                 7  BY TYPE OF WOOD AND DBH CLASS

                YOUR SELECTION PLEASE?

                                                  0

TOTAL NUMBER OF RECORDS IN THIS FILE -  :        210:
```

Figure C56. Top screen is for Option D, bottom screen for Option E

```
COMPARTMENT TIMBER TOTALS SORT SELECTION

   0  RETURN TO TIMBER REPORT MENU
   1  AS GENERATED BY THE COMPUTER
   2  BY STAND
   3  BY PINE
   4  BY OAK
   5  BY HICKORY
   6  BY HARDMAST
   7  BY HARDWOOD
   8  BY NONCLASSIFIED
   9  BY STAND TOTALS


        YOUR SELECTION PLEASE?          0
```

Figure C57. Sort options for selection D

PART VIII: COMPARTMENT STATUS (OPENING MENU OPTION 7)

83. The compartment status option permits the user to find out the status of a compartment. When the user finishes a task, the system updates this file. No reports are actually generated from this option. The system takes a few seconds to sort the file by compartment code (Figure C58). After this, the system goes into the dBASE III Plus browse routine. Unlike the edit routine, the entire compartment status record is shown on the screen. For a review of the browse routine, the user should refer to the dBASE III Plus manual.

```
Hold it a second while I clean up the file.
```

Figure C58. Message while COMPSTAT file is being sorted

84. Figure C59 lists the fields in the file. COMPNAME stores the three-character compartment code. LASTACC stores the date the file was last accessed. ALLDATAENT is the date all the data were completely entered. PLOTEDIT is the date the data were completely edited. PRESCRIPT is the date that the prescription summary was entered. PRESEDIT is the date that the prescription summary was edited. HSITIMB is the date that the compartment was run on the HSI and timber calculations while FORCAST is the date that TIMBER forecasts were made (not yet available).

Field	Field Name	Type	Width	Dec
1	COMPNAME	Character	3	
2	LASTACC	Date	8	
3	ALLDATAENT	Date	8	
4	PLOTEDIT	Date	8	
5	PRESCRIPT	Date	8	
6	PRESEDIT	Date	8	
7	HSITIMB	Date	8	
8	FORCAST	Date	8	
** Total **			60	

Figure C59. Structure of COMPSTAT file

PART IX: UTILITIES MENU (OPENING MENU OPTION 8)

85. Option 8 from the opening menu consists of programs to make backups easier for the user. Backups are required for the day when the hard disk is accidentally formatted or crashes. It is recommended that at least two backups be kept of everything that the user considers valuable. The system and compartment data are considered valuable. While it takes only a few minutes to make a backup of a compartment, it takes several days to retype the data. There is no logical explanation for not having required backup procedures. In general, this utility uses standard MS DOS commands. The following discussion briefly explains each option. After entering an "8" from the opening menu, the user is presented with the utilities menu (Figure C60).

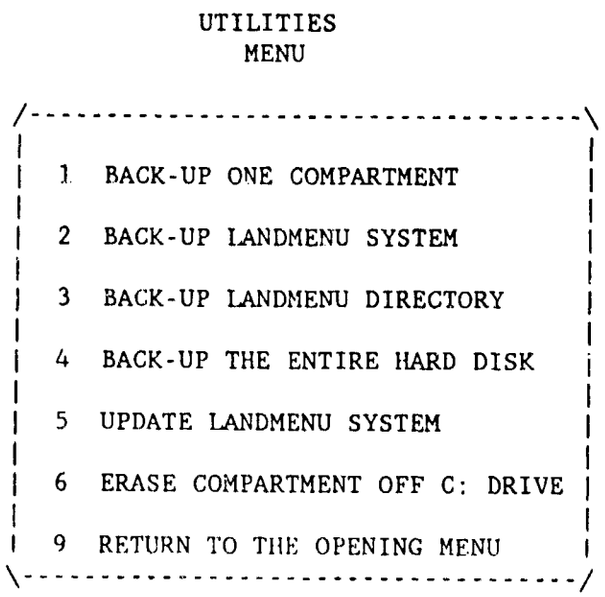


Figure C60. Utilities menu

86. Option 1 from the utilities menu permits the user to create a backup of all the data related to one compartment. The MS DOS COPY command is used for this operation. The user only needs to enter the three-character compartment code (Figure C61). The system then reminds the user to place a floppy disk in drive B. After doing so, the user hits the Enter key and the

```
THIS IS A LIST OF AVAILABLE COMPARTMENTS.
COMPDD3.DBF        COMPK20.DBF        COMP000.DBF

 70372 bytes in      3 files.
331776 bytes remaining on drive.

ENTER COMPARTMENT COMP  DD3.DBF    (ENTER BLANK TO QUIT.)
```

Figure C61. System request for compartment code

system will transfer all associated compartment files from the hard disk to the floppy disk.

87. Option 2 makes a copy of the software to run the LANDMENU system. Again, the MS DOS COPY command is used for this option. Two floppy disk backups are provided with the initial system. However, as the user enters data through normal daily activities, the contents of files will change. This option makes a complete copy of the existing data and systems. This is useful if the system should have a hard disk failure and lose all data and programs. The backup will be placed on a disk inserted into drive A.

88. Option 3 will back up everything in the LANDMENU directory. Thus, both programs and data files will be saved. This is useful when the user does not keep an accurate record of everything that is going into the computer. Before erasing files, this option is helpful. If a file is needed later, it can be recovered from the floppy disk. This routine uses the MS DOS BACKUP program. Therefore, if files need to be reloaded onto a computer, they will need to be reloaded using the MS DOS RESTORE command. The user should refer back to the MS DOS command manual for instructions to use the RESTORE command. Again, drive A receives the backup files.

89. Option 4 makes a complete backup of the entire hard disk. This option also uses the MS DOS BACKUP command. The backup will be sent to disk drive A. This procedure can take several hours to complete and must be regularly monitored. It is recommended that the user obtain a tape backup unit which requires no monitoring by the user, or software such as FASTBACK, which can make backups in 30 min or less. Although it greatly depen on the amount of computer usage, it is normally recommended that even light users of computers make weekly backups.

90. Option 5 is selected if there are any changes made in the system after it is installed. The user would receive a floppy disk from the Waterways Experiment Station, place the disk in the appropriate drive, and choose this option. The program updates all necessary files.

Tab 1, Appendix C: Reports

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PAGE

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MISSING

IN

ORIGINAL

DOCUMENT

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SIMPLE LISTING OF INPUT DATA FOR FIELDDAT FILE

COMP	STAND	LN	PN	FTP	SC	M/C	OP	MTP	AGE	HGT	PBA	HBA	WINTER	HERBFOOD	HERBCOVR	EC	NG	SM	PB	RC	GT
DD3	01		01	31	12	1	03	231			40		000000	000000	001212	1	0	1			
DD3	01		02	31	12	1	03	231			90		000000	000000	000000	1	0	1			
DD3	01		03	31	12	1	03	231			40		000000	000000	000000	1	0	1			
DD3	01		04	31	12	1	03	231			30	10	000000	000000	000000	1	0	1			
DD3	01		06	31	12	1	03	231			20	40	000000	000000	210020	1	0	1			
DD3	01		08	31	12	1	03	231			40	20	000000	000000	000000	1	0	1			
								.													
								.													
								.													
DD3	04		02	31	12	1	04	231					033204	000000	432104	1	0	1			
DD3	04		03	31	12	1	04	231					123446	000000	121343	1	0	1			
DD3	04		04	31	12	1	04	231					343140	000000	122113	1	1	1			
DD3	07		01	13	12	1	05	262				40	000000	000000	010140	1	0	1			
DD3	07		02	13	12	1	05	262				60	110000	000000	000000	1	0	1			
DD3	07		03	13	12	1	05	262			10	20	111111	000000	000000	1	0	1			
DD3	07		04	13	12	1	05	262			30		111111	000000	111111	1	0	1			
DD3	07		05	13	12	1	05	262			50		100230	000000	032110	1	0	1			
DD3	07		06	13	12	1	05	262			10		000000	000000	040010	1	0	1			
DD3	07		07	13	12	1	05	262			50	20	000000	000000	000000	1	0	1			
								.													
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REPORT OPTION A: EDIT LISTING

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TOTAL LISTING OF SPECIES

SPECIES	DBH	COMP	STANDNO	LINENO	PLOTNO	TYPE WOOD	COVER TYPE
LBP	18	DD3	01		01	PINE	NARROW
LBP	16	DD3	01		01	PINE	NARROW
LBP	14	DD3	01		01	PINE	NARROW
LBP	14	DD3	01		01	PINE	NARROW
LBP	16	DD3	01		02	PINE	NARROW
LBP	14	DD3	01		02	PINE	NARROW
LBP	10	DD3	01		02	PINE	NARROW
LBP	10	DD3	01		02	PINE	NARROW
LBP	14	DD3	01		02	PINE	NARROW
LBP	16	DD3	01		02	PINE	NARROW
LBP	12	DD3	01		02	PINE	NARROW
LBP	14	DD3	01		02	PINE	NARROW

REPORT OPTION B: EDIT LISTING

COMPARTMENT 003

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COMPARTMENT PRESCRIPTION SUMMARY

STAND NO	FOREST TYPE	STAND COND	GROSS ACRES	INCLU ACRES	NET ACRES	MOC	OPER	AGE YEAR	MGMT TYPE	INDEX	CULT NEED 1	DATE WORK 1	CULT NEED 2	DATE WORK 2	FY & REGN	PRES DATE	GS HSI	BW HSI	WTD HSI	EWT HSI	RCWP REPRO HSI	RCWP FORAG HSI
1	31	12	175	0	175	1	04	1923	Z31	070	80	88	80	93		1984	0.06	0.11	0.02	0.26	0.53	0.76
2	25	12	86	0	86	1	04	1907	131	070	80	88	80	93		1984	0.00	0.00	0.00	0.04	0.00	0.00
3	31	12	26	0	26	1	04	1920	Z31	070	80	88	80	93		1984	0.00	0.11	0.33	0.22	0.55	0.81
4	31	12	18	0	18	1	04	1933	Z31	080	80	88	80	93		1984	0.00	0.06	0.35	0.20	0.23	0.30
5	25	12	18	1	17	1	13	1927	131	070	80	88	80	93		1984	0.13	0.30	0.35	0.53	0.50	0.93
6	90		110	0	110											1984	0.00	0.00	0.00	0.00	0.00	0.00
7	13	12	186	0	186	1	04	1934	131	080	80	88	80	93		1984	0.46	0.09	0.13	0.66	0.00	0.53
8	760		48	0	48											1984	0.00	0.00	0.00	0.00	0.00	0.00
9	31P	13	21	0	21	1	01	1987	Z31	070	06	90				1984	0.00	0.20	0.40	0.37	0.00	0.00
10	25	12	26	2	24	1	04	1936	131	070	80	88	80	93		1984	.00	0.[illegible]	.00	0.04	0.00	0.00
11	31P	13	51	0	51	1	01	1987	Z31	070	06	90				1984	0.12	0.18	0.14	0.42	0.00	0.00

REPORT OPTION C: COMPARTMENT INFORMATION

REPORT DESCRIPTION: LIST STAND TOTAL DATA SORTED BY: AS GENERATED BY COMPUTER
STAND TIMBER REPORT

COMPARTMENT	STAND	TOTAL SAMPLED TREES	BASAL AREA PER ACRE
003	1	60.00	37.50
003	3	29.00	48.33
003	4	15.00	37.50
003	5	35.00	116.67
003	7	186.00	48.95
003	9	41.00	51.25
003	11	32.00	45.71

END OF FILE

REPORT OPTION D-1: TIMBER INFORMATION

REPORT DESCRIPTION: BASAL AREA PER ACRE SORTED BY: AS GENERATED BY COMPUTER
STAND TIMBER REPORT

COMP	STAND	********** BASAL AREAS ********** PINE	HARDWOOD	HARDMAST	OAK	HICKORY	OTHER	STAND
003	1	29.38	8.12	6.25	3.12	3.12	1.88	37.50
003	3	48.33	0.00	0.00	0.00	0.00	0.00	48.33
003	4	32.50	5.00	0.00	0.00	0.00	5.00	37.50
003	5	80.00	36.67	3.33	3.33	0.00	33.33	116.67
003	7	21.05	27.89	15.79	15.00	0.79	12.11	48.95
003	9	43.75	7.50	3.75	3.75	0.00	3.75	51.25
003	11	32.86	12.86	7.14	0.00	7.14	5.71	45.71

END OF FILE

REPORT OPTION D-9: TIMBER INFORMATION

TIMBER VOLUME REPORT
TOTALS

COMPARTMENT	PINE CORDS	HARDWOOD CORDS	PINE BOARD FEET (MBF)	HARDWOOD BOARD FEET (MBF)
A03	115.08	56.07	76760.17	26413.84
A04	64.91	91.02	76598.36	30159.52
A07	0.00	0.00	0.00	0.00
A08	0.00	0.00	0.00	0.00
A13	129.88	118.23	89503.76	42293.58
A14	22.27	29.05	19619.91	10714.30
A15	0.00	0.00	0.00	0.00
A18	77.37	72.20	73606.33	64711.36
AA1	11.93	22.47	19760.69	11710.96
B01	16.60	30.33	5206.50	13990.11
B02	40.02	38.03	3762.32	10424.84
B03	58.21	100.73	36179.21	47684.28
B04	50.46	86.71	31577.55	28431.84
B05	39.28	21.13	21188.93	10765.66
B06	21.23	51.47	21516.67	28821.61
BB1	29.60	68.04	47987.75	31105.00
BB2	44.11	31.22	24427.43	36260.16
BB3	28.07	62.31	82051.76	33169.25
BB4	62.22	61.77	42332.08	15674.78
BB5	59.61	33.51	39632.64	6200.66
BB6	33.55	27.86	18468.52	9011.30
BB7	0.00	0.00	0.00	0.00
BB8	17.43	58.11	33480.27	26718.50
BB9	3.48	7.38	13189.09	3674.10
C01	0.00	0.00	0.00	0.00
C02	0.00	0.00	0.00	0.00
C03	0.00	0.00	0.00	0.00
CC1	35.03	66.79	13828.46	28002.81
CC2	79.29	89.66	19018.16	35176.06
CC3	50.89	27.17	41941.93	11845.85
CC4	10.88	27.61	19452.75	14936.41
D01	0.00	0.00	0.00	0.00
D02	42.02	36.74	27203.20	13419.62

REPORT OPTION F: TIMBER INFORMATION

TIMBER VOLUME REPORT
TOTALS

COMPARTMENT	PINE CORDS	HARDWOOD CORDS	PINE BOARD FEET (MBF)	HARDWOOD BOARD FEET (MBF)
A03	115.08	56.07	76760.17	26413.84
A04	64.91	91.02	76598.36	30159.52
A07	0.00	0.00	0.00	0.00
A08	0.00	0.00	0.00	0.00
A13	129.88	118.23	89503.76	42293.58
A14	22.27	29.05	19619.91	10714.30
A15	0.00	0.00	0.00	0.00
A18	77.37	72.20	73606.33	64711.36
AA1	11.93	22.47	19760.69	11710.96
B01	16.60	30.33	5206.50	13990.11
B02	40.02	38.03	3762.32	10424.84
B03	58.21	100.73	36179.21	47684.28
B04	50.46	86.71	31577.55	28431.84
B05	39.28	21.13	21188.93	10765.66
B06	21.23	51.47	21516.67	28821.61
BB1	29.60	68.04	47987.75	31105.00
BB2	44.11	31.22	24427.43	36260.16
BB3	28.07	62.31	82051.76	33169.25
BB4	62.22	61.77	42332.08	15674.78
BB5	59.61	33.51	39632.64	6200.66
BB6	33.55	27.86	18468.52	9011.30
BB7	0.00	0.00	0.00	0.00
BB8	17.43	58.11	33480.27	26718.50
BB9	3.48	7.38	13189.09	3674.10
C01	0.00	0.00	0.00	0.00
C02	0.00	0.00	0.00	0.00
C03	0.00	0.00	0.00	0.00
CC1	35.03	66.79	13828.46	28002.81
CC2	79.29	89.66	19018.16	35176.06
CC3	50.89	27.17	41941.93	11845.85
CC4	10.88	27.61	19452.75	14936.41
D01	0.00	0.00	0.00	0.00
D02	42.02	36.74	27203.20	13419.62

REPORT OPTION F: TIMBER INFORMATION

COMPARTMENT 003

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WILDLIFE
AVERAGES

STAND NUMBER	HERBACEOUS FOOD AVERAGE	HERBACEOUS COVER AVERAGE	WINTER BROWSE AVERAGE	ESCAPE COVER AVERAGE	NESTING GRASS AVERAGE	SOFT MAST AVERAGE
1	0.00	0.81	0.00	0.69	0.00	0.75
2	0.00	0.00	0.00	0.00	0.00	0.00

GRAY SQUIRREL
HABITAT SUITABILITY INDEX

STAND NUMBER	SUITABILITY INDEX 1	SUITABILITY INDEX 2	SUITABILITY INDEX 3	SUITABILITY INDEX 4	OVERALL HABITAT SUITABILITY INDEX
1	0.02	0.20	0.91	0.48	0.06
2	0.00	0.00	0.00	0.00	0.00

BOBWHITE QUAIL
HABITAT SUITABILITY INDEX

STAND NUMBER	SUITABILITY INDEX 1	OAK SI	PINE SI	SUITABILITY INDEX 2	SUITABILITY INDEX 3	SUITABILITY INDEX 4	OVERALL HABITAT SUITABILITY INDEX
1	0.00	0.02	0.61	0.63	-0.20	0.00	0.11
2	0.00	0.00	0.00	0.00	-0.20	-0.30	0.00

WHITE-TAILED DEER
HABITAT SUITABILITY INDEX

STAND NUMBER	SUITABILITY INDEX 1	SUITABILITY INDEX 2	SUITABILITY INDEX 3	OVERALL HABITAT SUITABILITY INDEX
1	0.00	0.02	0.20	0.02
2	0.00	0.00	0.00	0.00

EASTERN WILD TURKEY
HABITAT SUITABILITY INDEX

STAND NUMBER	SUITABILITY INDEX 1	SUITABILITY INDEX 2	SUITABILITY INDEX 3	SUITABILITY INDEX 4	SUITABILITY INDEX 5	FOOD SI	BROOD SI	OVERALL HABITAT SUITABILITY INDEX
1	0.05	0.02	0.20	0.20	0.00	0.26	0.05	0.26
2	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.04

RED-COCKADED WOODPECKER
HABITAT SUITABILITY INDEX

STAND NUMBER	SUITABILITY INDEX 1	SUITABILITY INDEX 2	SUITABILITY INDEX 3	SUITABILITY INDEX 4	SUITABILITY INDEX 5	SUITABILITY INDEX 6	REPRODUCTION HABITAT SUITABILITY INDEX	FORAGING HABITAT SUITABILITY INDEX
1	0.15	0.49	1.00	1.00	0.78	0.57	0.53	0.76
2	1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00

REPORT OPTION G: WILDLIFE INFORMATION

COMPARTMENT 003

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STAND HABITAT
SUITABILITY INDEXES

STAND NUMBER	GRAY SQUIRREL	BOBWHITE	WHITE-TAILED DEER	EASTERN WILD TURKEY	RED-COCKADED WOODPECKER REPRODUCTION	RED-COCKADED WOODPECKER FORAGING
1	0.06	0.11	0.02	0.26	0.53	0.76
2	0.00	0.00	0.00	0.04	0.00	0.00
3	0.00	0.11	0.33	0.22	0.55	0.81
4	0 00	0.06	0.35	0.20	0.23	0.30
5	0.13	0.30	0.35	0.53	0.50	0.93
7	0.46	0.09	0.13	0.66	0.00	0.53
9	0.00	0.20	0.40	0.37	0.00	0.00
10	0.00	0.00	0.00	0.04	0.00	0.00
11	0.12	0.18	0.14	0.42	0.00	0.00

REPORT OPTION H: WILDLIFE INFORMATION

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COMPARTMENT
HABITAT SUITABILITY INDEXES
WITH
GIS CODES

COMP	GRAY SQUR HSI	I	S	A	Q L	BOB WHITE HSI	I	S	A	Q L	WHITE TAIL DEER HSI	I	S	A	Q L	EASTN WILD TURKY HSI	I	S	A	Q L	RCWP REPO HSI	I	S	A	Q L	RCWP FORG HSI	I	S	A	Q L
A03	0.00	1	P			0.00	1	P			0.00	1	P			0.00	1	P			0.00	1	P			0.00	1	P		
A04	0.33	2	F			0.26	2	F			0.16	2	F			0.08	1	P			0.12	2	F			0.15	2	F		
A07	0.19	2	F			0.33	2	F			0.18	2	F			0.06	1	P			0.04	1	P			0.44	3	G		
A08	0.16	2	F			0.51	3	G			0.07	1	P			0.09	1	P			0.29	2	F			0.71	4	VG		
A13	0.27	2	F			0.32	2	F			0.12	2	F			0.07	1	P			0.13	2	F			0.41	3	G		
A14	0.34	2	F			0.13	2	F			0.23	2	F			0.07	1	P			0.10	1	P			0.20	2	F		
A15	0.18	2	F			0.31	2	F			0.07	1	P			0.06	1	P			0.18	2	F			0.41	3	G		
A18	0.34	2	F			0.21	2	F			0.10	1	P			0.07	1	P			0.06	1	P			0.10	1	P		
AA1	0.34	2	F			0.09	1	P			0.08	1	P			0.06	1	P			0.10	1	P			0.12	2	F		
B01	0.17	2	F			0.04	1	P			0.09	1	P			0.05	1	P			0.06	1	P			0.08	1	P		
B02	0.28	2	F			0.08	1	P			0.11	2	F			0.06	1	P			0.00	1	P			0.04	1	P		
B03	0.35	2	F			0.15	2	F			0.14	2	F			0.08	1	P			0.04	1	P			0.13	2	F		
B04	0.36	2	F			0.20	2	F			0.15	2	F			0.06	1	P			0.09	1	P			0.21	2	F		
B05	0.28	2	F			0.27	2	F			0.16	2	F			0.07	1	P			0.10	1	P			0.29	2	F		
B06	0.56	3	G			0.35	2	F			0.24	2	F			0.09	1	P			0.00	1	P			0.35	2	F		
BB1	0.40	3	G			0.15	2	F			0.12	2	F			0.07	1	P			0.23	2	F			0.33	2	F		
BB2	0.48	3	G			0.26	2	F			0.20	2	F			0.08	1	P			0.16	2	F			0.40	3	G		
BB3	0.53	3	G			0.28	2	F			0.23	2	F			0.10	1	P			0.00	1	P			0.00	1	P		

REPORT OPTION I: WILDLIFE INFORMATION

Tab 2, Appendix C: Error Messages

Error Messages

91. When errors occur, the user should write down as much information as possible describing the error. At a minimum, the following information is required:

a. Menu option selected at the time.

b. Responses to any computer questions.

c. Compartment in use at the time.

d. Floppy disks in use.

(1) Drives where the floppies were located.

(2) Whether or not the drive doors were closed.

(3) How the disks were placed in the drive.

e. Messages given by the computer.

92. Before contacting WES, the user should take a careful look at the data. In most cases, there is an error in data. The system checks for most data problems, but there are always new ways users manage to trick the system. Eventually, the system cannot operate with certain data and the system stops. The user should edit the data and then try to rerun the selected option.

93. If the LANDMENU system dies and comes to a period (.), the user has defaulted to the dBASE III command system. To proceed back into the LANDMENU system, the user should type DO LANDMENU at the period.

94. If the system dies and comes to the MS DOS prompt, the user should type L and hit enter. If the user receives a "bad command" message, the user should type CD and hit enter; then, the user should hit L.

> MAIN CAUTION: The system will note problems in the data on printed output. The user must keep these printouts, store them with the data disk, and must refer to them before using the reports. If the user fails to enter the number of acres for the stand, the system will note this, but it will not show up on any subsequent reports. Therefore, the user must be wary of using totals for a compartment if some compartments have erroneous data.

95. After editing data, the HSI and timber calculation system may be run. The calculations will not destroy the original data. Thus, the user may continuously update the data and rerun the computations.